

ST. LOUIS AIRPORT EXPANSION DEMOLITIONS DATA EVALUATION

by

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HISTORY

Roger Wilmoth and Glenn Shaul had an initial conference call on Friday, June 11, 2004 and had follow-on conversations with Joletta Golik, St. Louis Airport Authority Expansion Team, about the monitoring of demolitions at the St. Louis Airport, relative to an email with monitoring data received from Becky Dolph, OGC, Region VII. Prior to the call, Roger and Glenn had reviewed the data received from Becky and had reviewed the St. Louis Airport Expansion web site, which is excellent and very informative. The web address is <http://www.lambert-stlouis.com/expansion/index.htm>. On June 21, 2004, Roger and Glenn met in St. Louis with the airport staff along with Becky Dolph, Deputy Regional Counsel, Region VII and Lynn Slugantz, Acting Chief of the Region VII Radiation, Asbestos, Lead, and Indoor Air Branch. The St. Louis Airport Authority was represented by Gerard Slay, Deputy Director of the Airport, and his contractors for the expansion, Joletta Golik, Jim Moriarity, and Mike Mencin.

Gerard, Joletta and staff were quite well informed about the environmental effort in the expansion and felt strongly that they had performed all demolitions in the safest possible manner. They were extremely cooperative and very helpful and did all they could to meet our multitude of data and information requests as expeditiously as possible. Gerald also said that neither they, nor the County Health Department, had received any complaints about dust.

The purpose of this evaluation was to assess the adequacy of existing data/information in determining the effectiveness of the wet demolition process as implemented in St. Louis in controlling air emissions. We received statistical support from our contractor, Vicki Ann Lancaster, Ph.D., of Neptune and Co.

BACKGROUND

The expansion began in the mid-1990's and demolitions began in 1999. It is a \$1.1 billion dollar effort. An aerial view is shown in Figure 1.



Figure 1. Aerial views from February 2003 and May 2004 of the St. Louis Airport Expansion.

At the beginning of the project in 1999, there were about 2000 buildings to be demolished; about 1900 of these were residential units with most of these being single-story, two bedroom homes built on concrete slabs. There were also some two-story residences. The remaining 100 or so buildings were motels, light manufacturing facilities, churches, and schools. According to an article in the St. Louis Post Dispatch, airport Deputy Director Gerard Slay said that the St. Louis Airport Authority so far has used the wet demolition technique to level about 260 residential and eight commercial buildings that contained asbestos and that they had about 500 residences remaining (see Figure 2), and they don't know how many of those contain asbestos until they take the survey. Before demolition, a complete asbestos assessment survey was (is) done by a certified asbestos inspector for each building, detailing the asbestos locations and concentrations within the building. Also according to Mr. Slay, about 15 percent of the residences surveyed had greater than one-percent asbestos –containing materials (ACM) in the

building and these were typically joint compound and some sprayed-on decorative ceiling coatings. There was also vinyl asbestos tile and probable asbestos in the mastic. Where the tile was on the concrete, the airport wanted to recover the concrete for fill. The vinyl asbestos tile and mastic were removed by hand before recovering the concrete during the demolition and breaking it into basketball- size chunks for incorporation into the fill for the expansion effort. Where the tile was on wood substrates, the tile and wood floor were left intact and removed along with the building during the demolition process. The inspection also included vermiculite, but its use as insulation was found in only one building, which was a commercial building. That insulation was sampled and then analyzed for asbestos by the modified Chatfield method for floor tile (per St. Louis County's Department of Health recommendation to Gerard Slay), and the results were negative. Vermiculite was also found in some textured ceiling applications.

Site property acquisition plans are presented in Figure 2 and a general map of the affected area is shown in Figure 3.

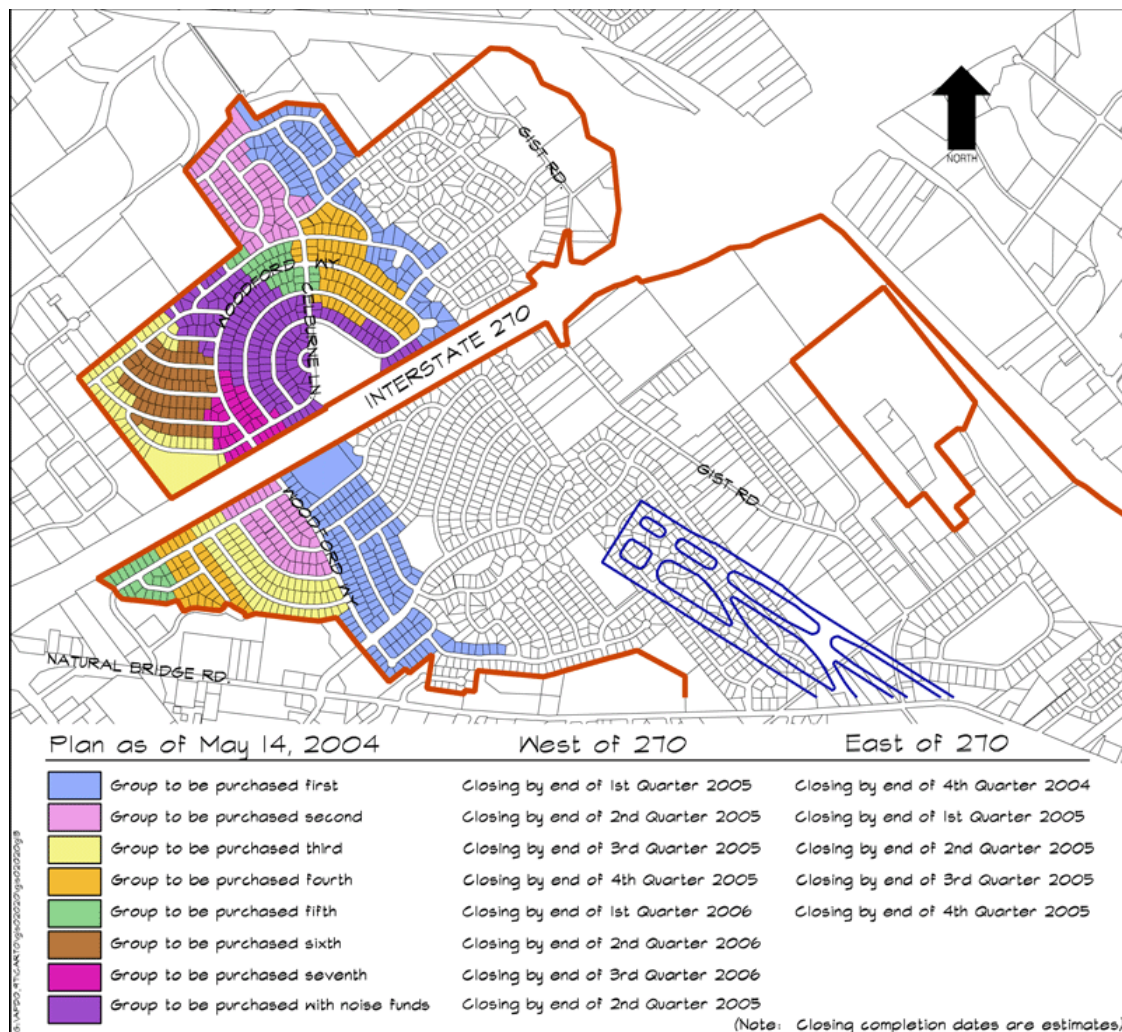


Figure 2. Purchasing plan for the St. Louis Airport Expansion.

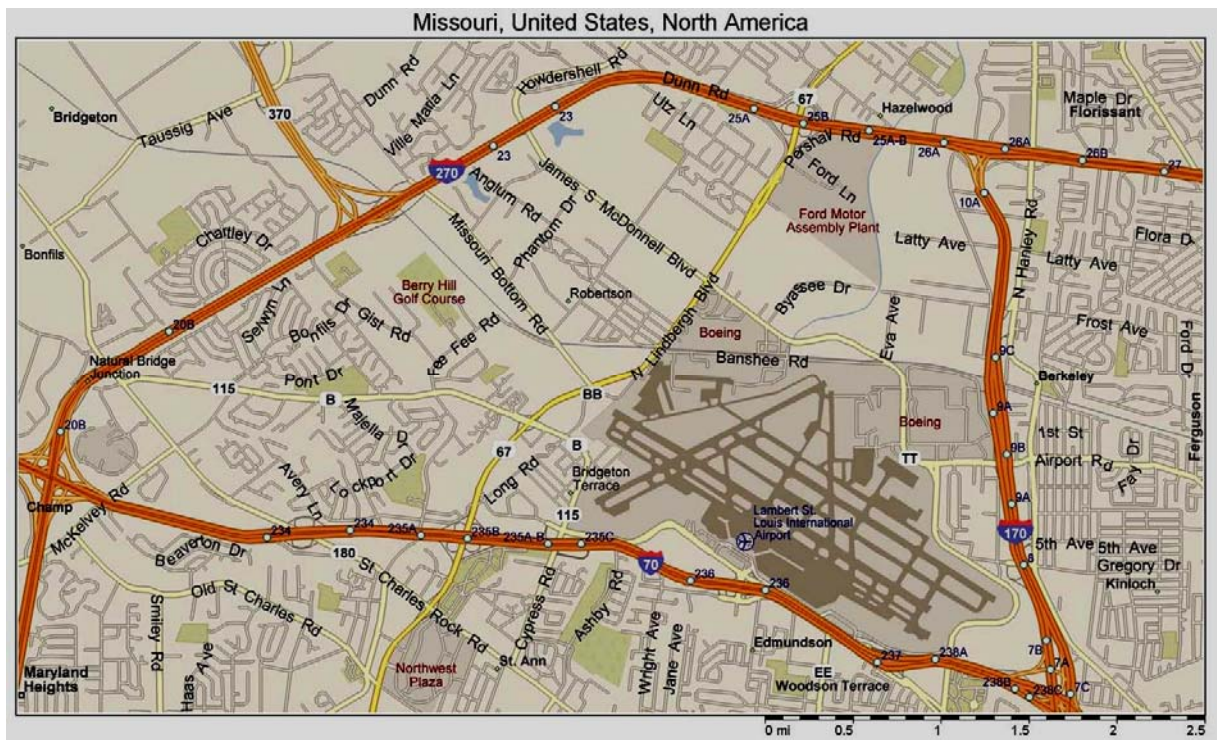


Figure 3. Map of the St. Louis Airport Expansion site.

DEMOLITION PROCESS

The demolition activities were obviously integrally tied to property acquisition. The acquisition process was dictated by funding constraints and timing of appropriations. Unfortunately, the sequencing of demolition locations in areas not in the immediate path of the runway construction appeared almost random, particularly in those areas that had to be vacated because of the FAA noise corridors, such that some buildings were demolished in close proximity to neighboring houses.

The majority of the larger commercial buildings were demolished by National Emission Standard for Hazardous Air Pollutants (NESHAP) technique (removal of friable-ACM under containment, followed by demolition). Some portion was done by the wetting process and some was a combination of the two. The choice was site-specific, based upon ease of access to the ACM, site safety concerns, etc. All of the non- asbestos-containing residences were done by standard demolition with exterior dust suppression by wetting during demolition and loading. This use of water in this technique was often confused by residents and visitors to indicate wet removal of asbestos, but no interior wetting was done for these standard demolitions and no ambient monitoring was done for standard demolitions.

If the residences contained wall-surfacings or wall components (joint compound) that were asbestos-containing, they became candidates for the wet demolition process. However, asbestos-containing floor coverings and mastic that were on concrete slabs were removed by conventional abatement practices (full containment), so that the concrete could be recovered for fill. Wet demolitions involved spraying the interior with water from a fire hose, and then lifting the corner of the roof to spray the attic before demolition. Demolition was typically accomplished with a backhoe (probably a track hoe) and front-end loader. The whole demolition process for residences took place within a single day and had to be completed in time for the trucks to reach the landfill, which closed at 3:00. For most residences, the demolition was completed in an hour or two, followed by removal of debris.

In the beginning for ACM-containing buildings, two hoses were used for wetting but this often caused over-wetting so later a single hose was used. The outside and the inside of the buildings were wetted before and during demolition and during loading of debris into trucks lined with 6-mil polyethylene. When the trucks were filled, all flaps were folded over the top of the truck and sealed with a spray-on adhesive and then covered with a tarp before the truck left the site. Also, the truck and tires were rinsed down before exiting the site. The goal of the wetting process was to prevent visible emissions from leaving the site (which they typically defined as the property boundary). All workers wore personal protective equipment. Wetting was not possible during freezing conditions, and no wet demolitions proceeded during these conditions. Approximately 275 residences containing ACM were demolished by the wet process to date.

AIR MONITORING

For asbestos-containing buildings, air samples were collected upwind and downwind of the demolition activities for Phase Contrast Microscopy (PCM), DUST, and Transmission Electron Microscopy (TEM) analyses by the contractors of the Airport Authority. The reason for the sampling was to act as a quality check on the demolition contractor, not because of any regulatory requirement. About one-tenth of the wet demolitions were monitored for PCM, many less for DUST, and only a few for TEM. The non-asbestos demolitions were not monitored.

PCM of course is not specific for asbestos but measures fibers of all types that are five microns or larger in length and have a specific aspect ratio (length to width ratio of 3:1 or greater). PCM cannot “see” individual asbestos fibers because they are too thin to be resolved under the optical resolution, but it can “see” bundles of asbestos fibers. It cannot distinguish an asbestos bundle from a fiberglass or carpet fiber. In asbestos abatement processes in buildings, PCM misses being able to count up to 99-percent of the asbestos fibers actually present as they are either too short to be counted or too thin to be seen. To illustrate this, the following figure is from an EPA Office of Research and Development study done several years ago, and all the asbestos structures counted by (TEM) were plotted in Figure 4.

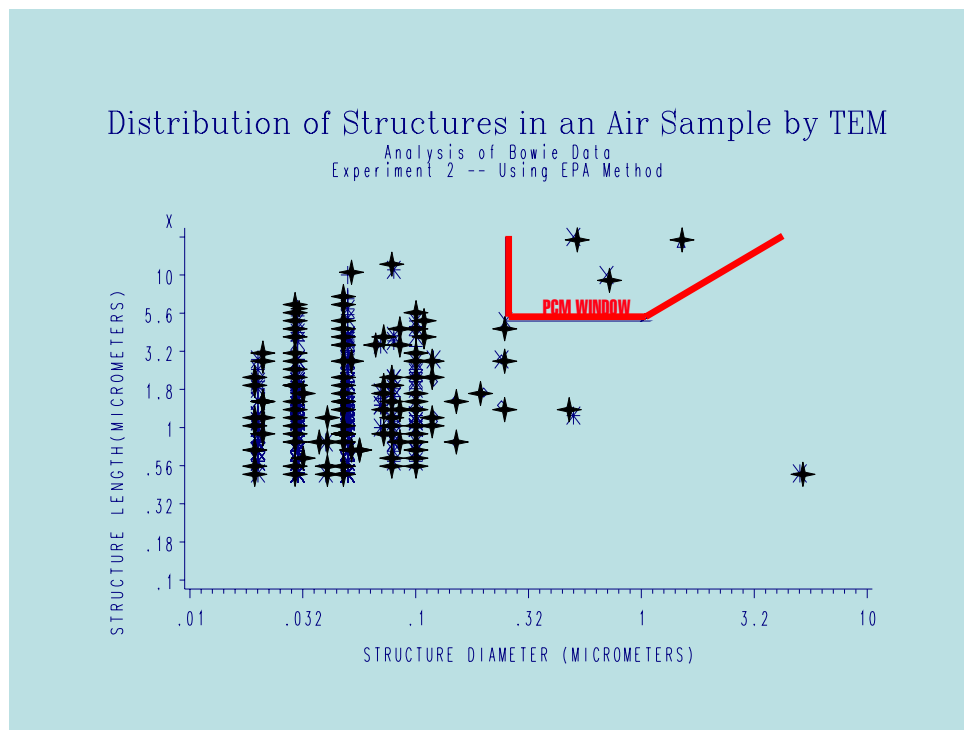


Figure 4. Illustration of the distribution of asbestos fiber sizes in an air sample.

In the upper right-hand corner is the PCM window, illustrating the small fraction of fibers that would have been counted by PCM. For demolition, the fiber size distribution is probably different as demolition probably has a larger percentage of longer fibers. Still, individual asbestos fibers are rarely seen using PCM. While the PCM values tell us nothing about asbestos concentrations, they do tell us about the effectiveness of the wetting process in controlling the release of larger fibers.

In the case of buildings containing asbestos, there were personal samplers on some or all of the workers for OSHA compliance monitoring, which is done by PCM. The personal sampling data were not used in this evaluation because the authors do not have the data from the personal samplers and detailed activity logs were not available for individual workers. It was also likely that the workers traversed into all quadrants of the demolition area; therefore the inclusion of these data would not be helpful to the understanding of whether or not there were differences in the up and downwind situations.

The number of samplers varied for the up and downwind monitoring. These samplers were located typically 50 to 60 feet from the buildings and placed three to five feet above the ground level. The choice of which buildings to monitor and the number of samplers, both up and downwind, was made on a site-specific basis by the field engineer/consultant. The major factors in this decision were the size of the demolition and the amount of activity involved. Sampling was initiated at the beginning of the demolition process and continued until the debris was removed and the site was judged clean by the on-site inspector. The first environmental consultant was Geotechnology. The current consultant is SAIC, since September 2003.

Transmission Electron Microscopy (TEM) analysis using the Asbestos Hazard and Emergency Response Act (AHERA) protocol was performed on a very few samples, typically when PCM values were elevated. Originally, there were five TEM measurements made (three up and two downwind) between October 1999 and May 2004; these were augmented in June 2004 by an additional four (two up and two downwind) by the NIOSH 7402 method from the only remaining PCM filters that had been archived. Samples were archived by the laboratories for thirty days and then disposed.

After considerable searching, the airport staff found only three pictures of actual wet demolitions. They said that there were virtually no pictures taken of these demolitions because of the emotional sensitivity of the residents about losing their homes.

The following two pictures (Figures 5 and 6) are from a wet demolition of a commercial building.



Figures 5 and 6. Pictures of wet demolition of commercial buildings.

The next picture (Figure 7) is a wet-demolition of a duplex residential building.



Figure 7. Wet demolition of a duplex residential building.

The following picture (Figure 8) is of a residence scheduled for wet demolition.



Figure 8. Residence tentatively slated for wet demolition.

DATA DESCRIPTION

Data Summary

Samples for PCM, f/cc, DUST, mg/m³, and TEM, s/cc were collected at the Lambert-St. Louis International Airport from 10/99 to 05/04. The samples were collected from 36 demolitions sites; seven commercial and 29 residential. Each residential demolition was completed in one day and most commercial sites required more than one day of demolition. At most sites, sampler(s) were placed in both the up- and downwind directions, three to five feet off the ground, and approximately 50 to 60 ft from the demolition activities. However, for each sampling day, not all three parameters (response variables-DUST, PCM, and TEM) were sampled, and in some cases samplers were placed in only one direction. The total number of individual sampler measurements for the three response variables is provided in Table 1. There were many instances where the data were reported as below detection levels; in these cases, the detection level was used in statistical analyses.

Table 1. Number of Response Variable Measurements by Direction and Building Type.

Bldg. Type	Direction	PCM	DUST	TEM
Residential	Upwind	42	20	3
	Downwind	55	28	2
Commercial	Upwind	79	29	2
	Downwind	78	27	2

Data Analysis Approach

The data were separated into two groups for independent analysis; the first group was residences and the second was commercial buildings. For each of those groups, two separate analyses were conducted. First, all data were used to compare upwind and downwind values for each response variable (PCM and DUST—there were insufficient numbers of TEM to perform this analysis). Second, the means of the upwind and downwind measurements (paired means) for each separate building were used and those values were compared. This dual approach was necessitated by the lack of information regarding the sampling design. The rationale for these choices is provided in the following paragraphs.

Paired means were constructed to compensate for the potential bias in sampler locations (not all demolition sites had at least one up- and downwind sampler) and the lack of independence between sampling days (commercial sites had more than one sampling day, therefore sampling days within a commercial site are more correlated than sampling days between sites). Paired means for a site were calculated for those sites that had at least one upwind and one downwind measurement. In cases where there was more than one sampler and/or sampling day, the directional mean (upwind mean

and downwind mean) was calculated over all samplers and days. In cases where there was only one sampler in each direction, the individual measurements were used. For the 29 residential sites, there are 25 paired measurements for PCM, nine paired measurements for DUST, and one paired measurement for TEM. For the seven commercial sites, there are seven paired measurements for PCM, four paired measurements for DUST, and one paired measurement for TEM.

Due to the fact there are so few commercial site paired means, the data were also analyzed using the individual sampler measurements referenced in Table 1. While this may violate the assumption of independent observations, it is believed that the statistical analyses of the individual sampler measurements provide additional insight into the data.

No statistical analyses were conducted on the TEM data because of the few number of TEM samples. In the cases where there were paired measurements for TEM, the values were the same in both directions.

STATISTICAL ANALYSIS

Data were evaluated both descriptively and with inferential tests. Descriptive statistics included means, medians, maximum and minimum values, standard deviations, and multiple descriptive plots. Prior to inferential analysis, the data sets were first tested for normality (and were non-normally distributed). As a result, the Wilcoxon Signed Rank test was used as the inferential test. For this evaluation, the null hypothesis is that, on average, there is no difference in the upwind and downwind data sets. For each evaluation, a p-value was calculated which represents a strength of evidence that the null hypothesis is true. The smaller the p-value, the stronger the evidence is that the null hypothesis should be rejected. Given that the data used in the evaluation were collected for other purposes, it is appropriate to be liberal in rejecting the null hypothesis. Traditionally, setting a level of 0.10 as a rejection level would be considered more liberal than levels of 0.05 or 0.01 (e.g.; p-values < 0.10 would be considered significant).

Another way to determine if there are differences is to compare the upwind and downwind distributions using a goodness-of-fit (GOF) test. The null hypothesis of a goodness-of-fit test is that the empirical distribution follows a specific name brand distribution (for example, lognormal) or that two empirical distributions are the same (in this case the upwind and downwind distributions).

The complete statistical analysis report is presented in Appendix A.

CAVEATS

The data collected by the St. Louis Airport Authority were not obtained for scientific purposes. As a result the data set has many deficiencies. Much of the information that would be required for rigorous scientific evaluation does not exist. It is not known that upwind and downwind samples are true up and downwind values for the duration of the sampling event, as wind direction changes are common and were not continuously monitored at the site; therefore, the longer the sampling event

was, the greater the possibility that wind changes occurred. Again, this information simply is not available. It is less likely that wind change was as great of an issue in residential demolitions as in commercial demolitions because the residences were demolished in about an hour, whereas commercial buildings took many days. The distances from the demolition to the samplers were not known, and variations in these could have biasing effects upon the results. No QA/QC data were available to us for the analytical data that were provided. The data were collected however by environmental professionals and some trust must be placed in their expertise and judgment.

For the purpose of our evaluation we assumed the following:

- 1) Upwind and downwind samples were in fact up and downwind for the duration of the sampling event.*
- 2) The samplers were located distances and elevations from the demolition to encounter any plume generated and not at differential distances and elevations that would bias the results.*

RESULTS AND DISCUSSION

TRANSMISSION ELECTRON MICROSCOPY (TEM) RESULTS

Again, there were only five samples analyzed by TEM initially and then these were augmented by reanalyzing at our request the only four remaining archived PCM sample filters. Because there were so few TEM samples, statistical analysis was not appropriate.

Of the original five, one upwind TEM sample was 0.0163 asbestos structures/cc, and the remaining two up and two downwind levels were <0.005 s/cc. For reference, the AHERA protocol for the clearance and release of buildings for reoccupancy after abatement is 70 s/sq mm of filter surface area, which roughly equates to 0.02 s/cc. The AHERA clearance criterion is not health-based. Of the four PCM samples that were reanalyzed by TEM, there were no asbestos structures counted on any of these four filters, yielding sample values <0.005 s/cc. While these data are clearly insufficient to judge the effectiveness of the wet method, the low downwind concentrations observed are not cause for concern.

Figure 9 illustrates the TEM, PCM, and DUST values at the three sites where TEM data were acquired.

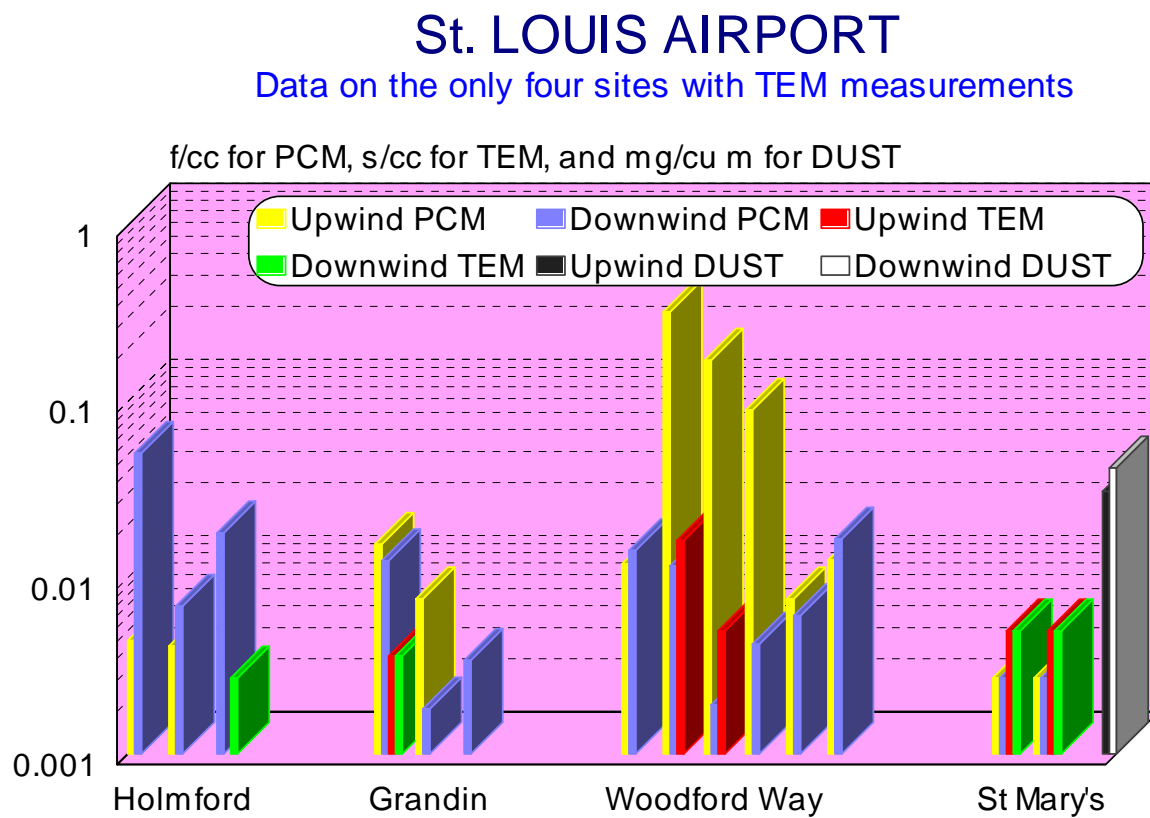


Figure 9. TEM, PCM, and DUST values at four sites where TEM values were obtained.

PHASE CONTRAST MICROSCOPY (PCM) RESULTS

PCM data are presented in Appendix B and shown in Figure 10.

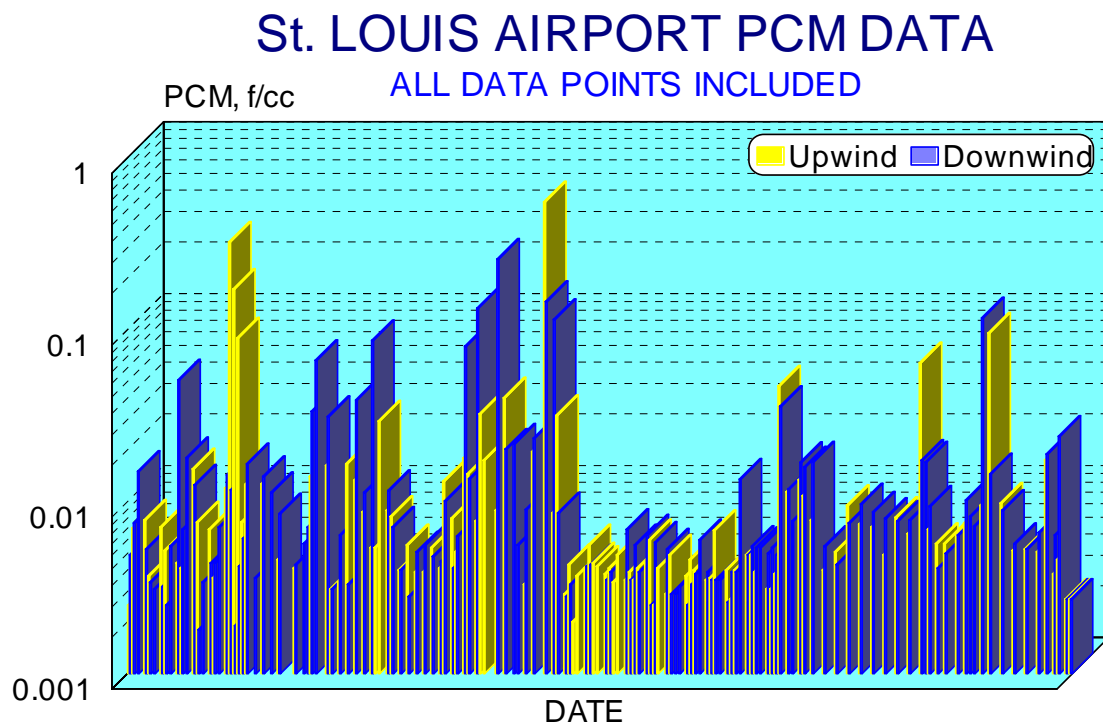


Figure 10. PCM data for all sites.

As previously described, the PCM data were evaluated separately for commercial and for residential buildings. These data are shown in Figures 11 and 12.

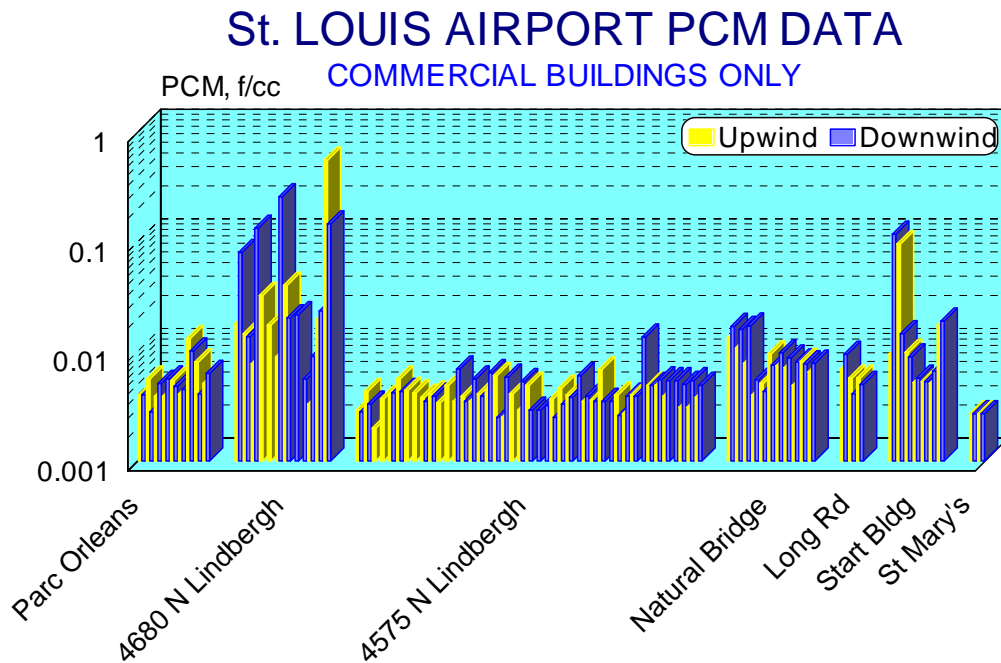


Figure 11. PCM data for commercial buildings only.

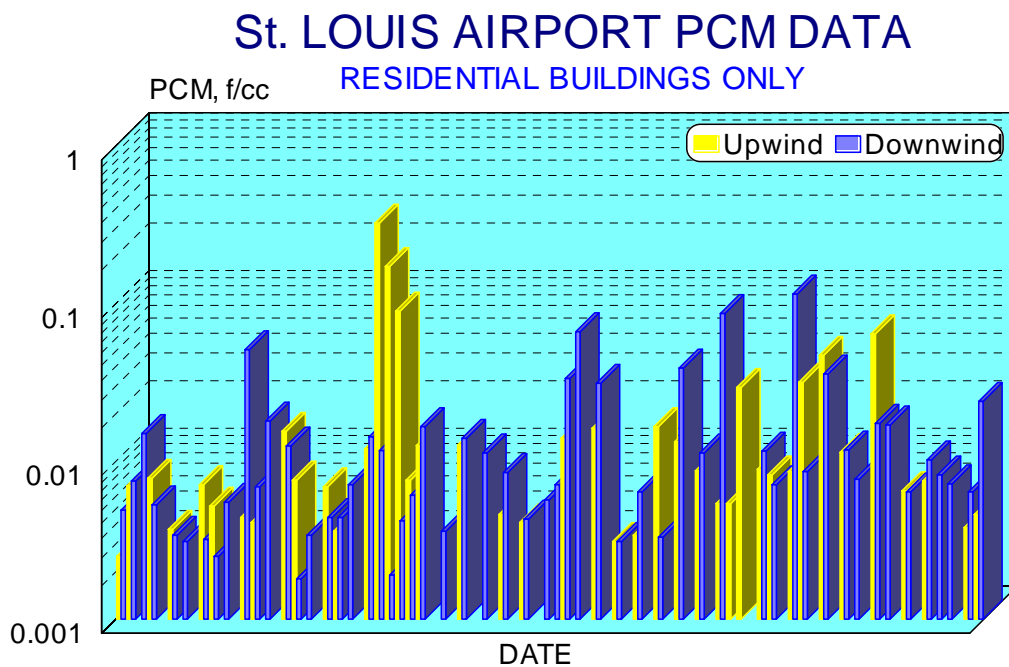


Figure 12. PCM data for residences only.

The descriptive statistics for PCM are presented in Tables 2 and 3.

Table 2. Summary Statistics for Upwind and Downwind by Building Type:

Demolition Site Individual Observations for PCM

PCM f/cc						
Method		Minimum	Median	Mean	Maximum	Std. Dev.
Residential	Up (n = 42)	0.0025	0.0077	0.0246	0.3231	0.0558
	Down (n = 55)	0.0018	0.0079	0.0156	0.1147	0.0211
Commercial	Up (n = 79)	0.0020	0.0049	0.0148	0.5541	0.0625
	Down (n = 78)	0.0025	0.0054	0.0157	0.2574	0.0380

Table 3. Summary Statistics for Upwind and Downwind by Building Type:

Demolition Site Paired Means for PCM

PCM f/cc						
Method		Minimum	Median	Mean	Maximum	Std. Dev.
Residential (n = 25)	Up	0.0031	0.0086	0.0163	0.1028	0.0228
	Down	0.0031	0.0097	0.0191	0.0865	0.0210
	Diff	-0.0731	-0.0010	-0.0028	0.0936	0.0296
Commercial (n = 9)	Up	0.0027	0.0061	0.0170	0.0716	0.0248
	Down	0.0027	0.0062	0.0178	0.0710	0.0246
	Diff	-0.0042	-0.0001	-0.0008	0.0006	0.0018

The inferential test results are in Tables 4 and 5.

Table 4. Results of the Kolmogorov-Smirnov GOF Test and Wilcoxon Signed Rank Test by Building Type:

Upwind versus Downwind PCM - Demolition Site Individual Observations

		KS GOF Test		Wilcoxon Signed Rank Test	
Method		Test Statistic	p-value of the Test Statistic	Test Statistic	p-value of the Test Statistic
Residential	PCM	0.0881	0.9623	0.2263	0.8210
Commercial	PCM	0.1334	0.4039	-0.8710	0.3838

Table 5. Results of the Kolmogorov-Smirnov GOF Test and Wilcoxon Signed Rank Test by Building Type:

Upwind versus Downwind PCM - Demolition Site Paired Means

		KS GOF Test		Wilcoxon Signed Rank Test	
Method		Test Statistic	p-value of the Test Statistic	Test Statistic	p-value of the Test Statistic
Residential	PCM	0.1923	0.7327	-1.1700	0.2418
Commercial	PCM	0.2000	0.9945	-0.6786	0.4974

The results of the inferential tests for PCM show that all p-values were well in excess of the 0.10 rejection level; therefore, the null hypothesis that there were no differences in the upwind and downwind data sets was not rejected in any of the evaluations performed.

The descriptive statistics support the same conclusion as illustrated in Figure 13 and also in additional graphs included in Appendix A.

PCM Up- and Down- Wind Individual Measurements f/cc in Order of Demolition Date, Solid Lines are Commercial Sites and Dashes Lines are Residential Sites.

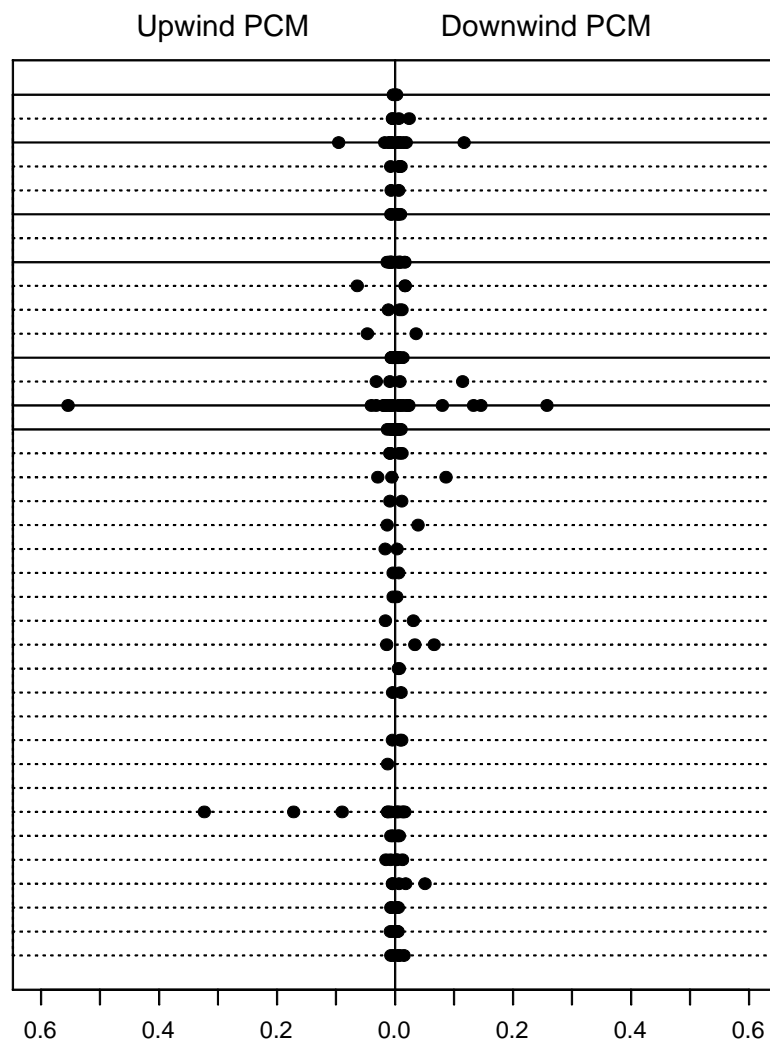


Figure 13. Scatter plot for the PCM data from residential sites.

DUST ANALYSIS RESULTS

DUST data are presented in Appendix B and shown in Figure 14.

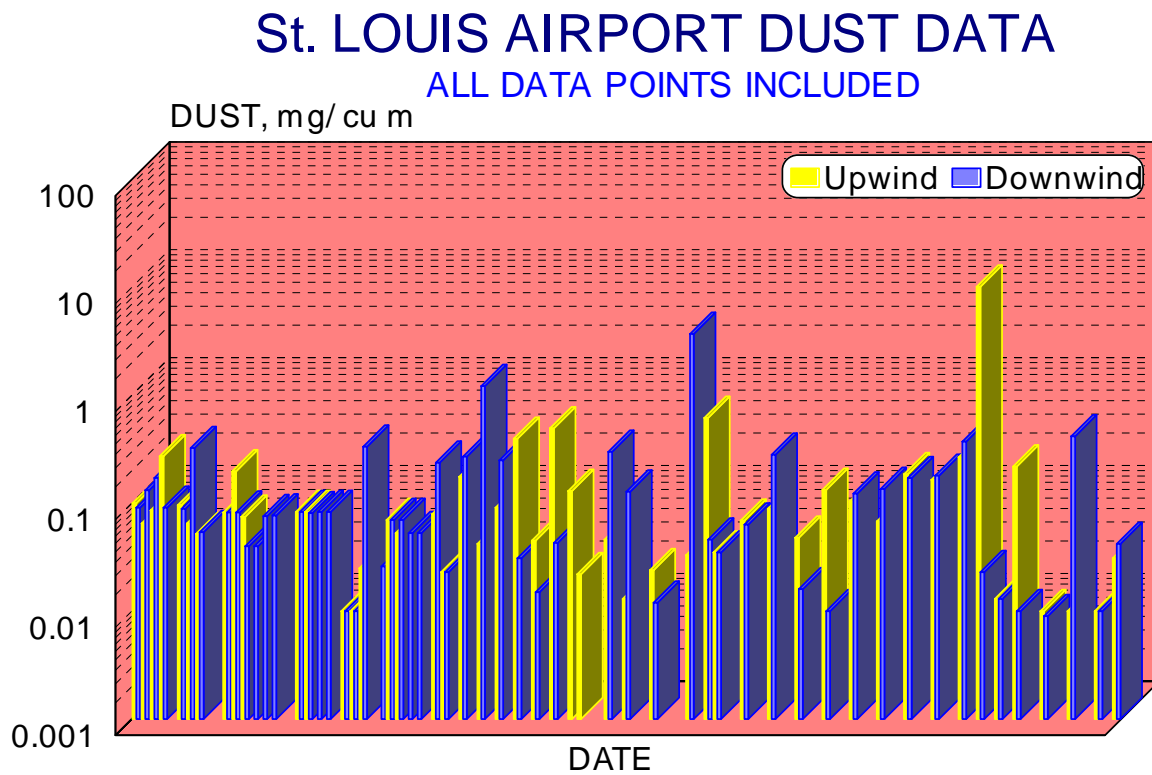


Figure 14. DUST data for all sites.

As previously described, the DUST data were evaluated separately for commercial and for residential buildings. These data are shown in Figures 15 and 16.

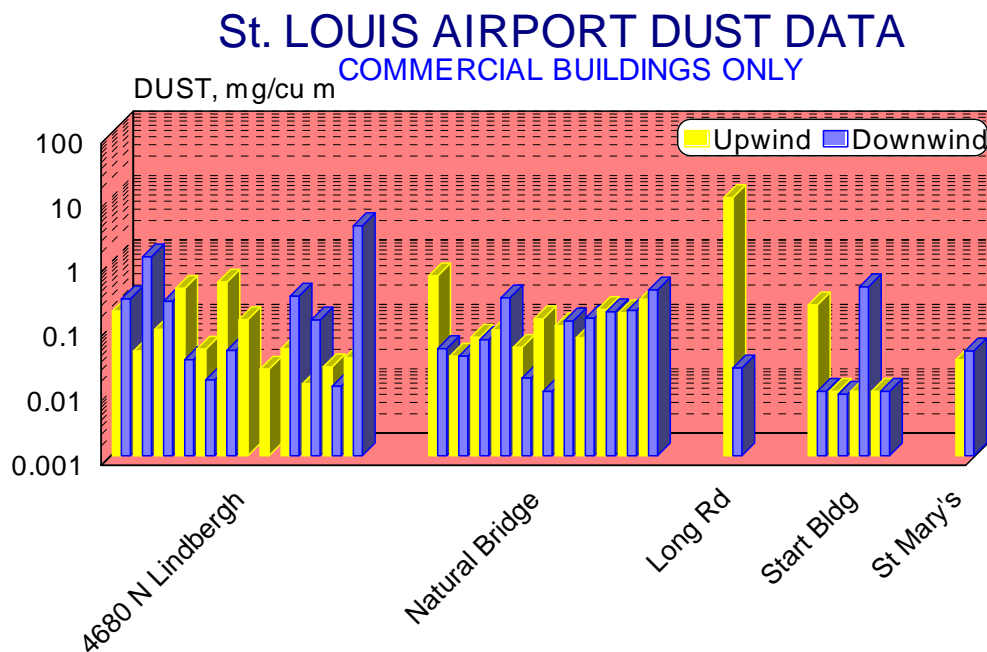


Figure 15. DUST data for commercial buildings only.

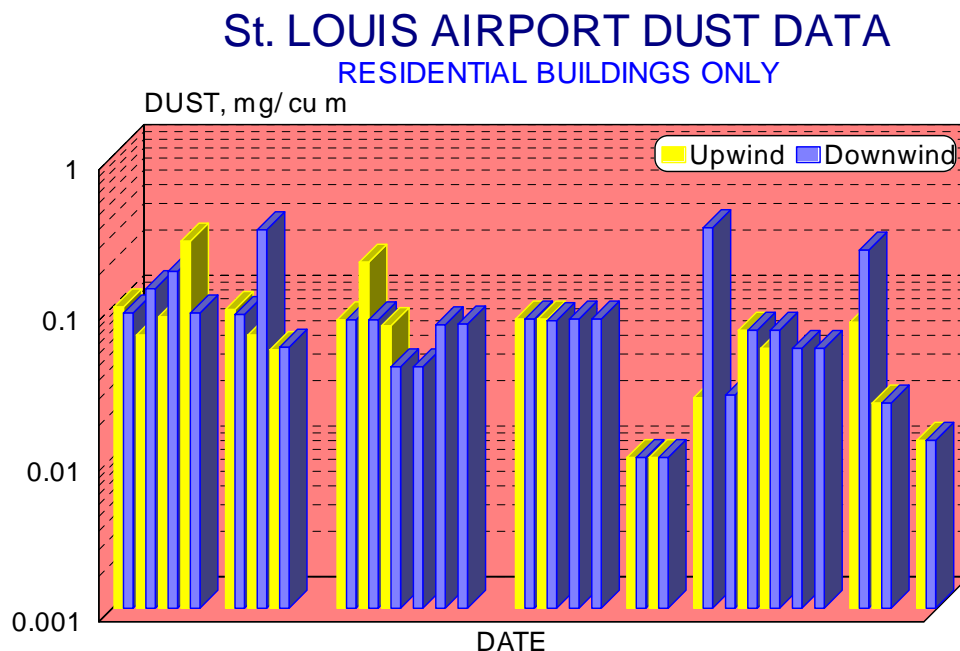


Figure 16. DUST data for residential buildings only.

The descriptive statistics for DUST are presented in Tables 6 and 7.

Table 6. Summary Statistics for Upwind and Downwind by Building Type:

Demolition Site Individual Observations for DUST

DUST mg/m³						
Method		Minimum	Median	Mean	Maximum	Std. Dev.
Residential	Up (n = 20)	0.0100	0.0725	0.0770	0.2730	0.0626
	Down (n = 28)	0.0036	0.0770	0.0891	0.3350	0.0826
Commercial	Up (n = 29)	0.0100	0.0690	0.4735	10.1600*	1.8681
	Down (n = 27)	0.0090	0.0634	0.2934	3.7070	0.7245

*With the outlier 10.1600, the Mean = 0.1277, Maximum = 0.6190, Std. Dev. = 0.1521.

Table 7. Summary Statistics for Upwind and Downwind by Building Type:

Demolition Site Paired Means for DUST

DUST mg/m³						
Method		Minimum	Median	Mean	Maximum	Std. Dev.
Residential (n = 7)	Up	0.0100	0.0615	0.0626	0.1310	0.0434
	Down	0.0043	0.0825	0.0840	0.1805	0.0562
	Diff	-0.1555	0.0000	-0.0215	0.0057	0.0611
Commercial (n = 4)	Up	0.0310	0.0942	0.0954	0.1351	0.0595
	Down	0.0420	0.1210	0.1340	0.2521	0.0874
	Diff	-0.1260	-0.0301	-0.0387	0.0316	0.0669

The inferential test results are in Tables 8 and 9.

Table 8. Results of the Kolmogorov-Smirnov GOF Test and Wilcoxon Signed Rank Test by Building Type:

Upwind versus Downwind DUST - Demolition Site Individual Observations

		KS GOF Test		Wilcoxon Signed Rank Test	
Method		Test Statistic	p-value of the Test Statistic	Test Statistic	p-value of the Test Statistic
Residential	DUST	0.1017	0.9975	-0.3360	0.7369
Commercial	DUST	0.1534	0.8439	-0.1011	0.9195

Table 9. Results of the Kolmogorov-Smirnov GOF Test and Wilcoxon Signed Rank Test by Building Type:

Upwind versus Downwind DUST - Demolition Site Paired Means

		KS GOF Test		Wilcoxon Signed Rank Test	
Method		Test Statistic	p-value of the Test Statistic	Test Statistic	p-value of the Test Statistic
Residential	DUST	0.2222	0.9895	-0.1793	0.8577
Commercial	DUST*	NA	NA	NA	NA

* Insufficient data for this test

The results of the inferential tests for DUST show that all p-values were well in excess of the 0.10 rejection level; therefore, the null hypothesis that there were no differences in the upwind and downwind data sets was not rejected in any of the evaluations performed.

The descriptive statistics support the same conclusion as illustrated in Figure 17 and also in additional graphs included in Appendix A.

Dust Up- and Down- Wind Individual Measurements mg/m³ in Order of Demolition Date, Solid Lines are Commercial Sites and Dashed Lines are Residential Sites.

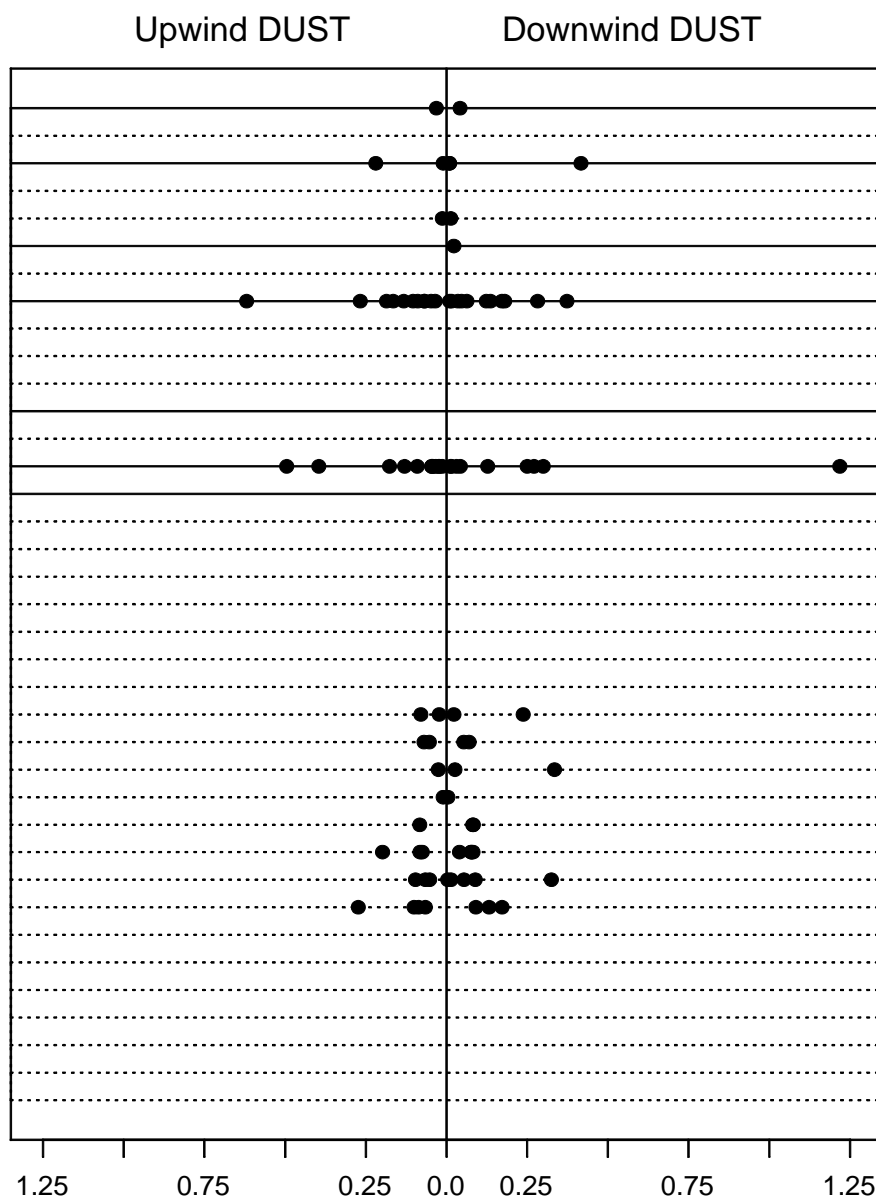


Figure 17. Scatter plot for DUST data.

SUMMARY

Our engineering analysis of these data is that while these studies were not conducted for the purpose of scientific scrutiny, the PCM and DUST data sets are large and we can glean some useful information from them. While PCM will not tell us if asbestos fibers were released, it does give us a good sense about the effectiveness of the wetting in the control of the release of large fibers. Since there was no statistically significant difference between the up and downwind PCM populations when viewed collectively, we conclude the wetting process appeared effective on average in the control of large-fiber release. If there had been a significant difference in the up and downwind concentrations, we would have concluded that the process was ineffective in controlling large fibers, and would therefore have been ineffective by inference in controlling asbestos release. Fortunately, this was not the case.

Similarly, the up and downwind DUST data were not statistically significantly different on a collective basis. The consistency of the DUST observation with that of the PCM data further substantiates that the process appeared effective on average in controlling large particle and fiber release.

Given the caveats of this report, no conclusions can be confidently drawn on the effectiveness of the wetting process for individual buildings.

Since asbestos fibers are in a vastly different size range and are not measured by either the PCM or DUST methods, we cannot infer that there was or was not a release of asbestos. The meager data set of four downwind TEM measurements were, however, all either very low or non-detect concentrations (<0.005 s/cc).

It is our recommendation that scientifically-designed studies be conducted to assess the effectiveness of the wet-demolition process in controlling asbestos release.

APPENDIX A - - STATISTICAL SUPPORT

GENERAL INFORMATION

QA ID No.:	N/A	Project QA Category:	N/A
EPA Technical Lead Person (TLP):	Roger Wilmoth		
Title:	Lambert-St. Louis International Airport Asbestos Data Analysis		
Data Provided By:	St. Louis Airport Authority		
Statistical Support Provided By:	Neptune and Co.		
Date:	Data Collected from Demolitions 10/99-5/04	Date Rec'd in QA Office:	06/21/04

REVIEW SUMMARY

Review Distribution Date	07/21/04	Endorsement Status	N/A
NRMRL-Ci QA Reviewer	Lauren Drees	No. of Findings	N/A
Telephone No.	513-569-7087	No. of Observations	N/A

The above data have been analyzed to determine if significant differences exist between measured upwind and downwind concentrations for phase contrast microscopy (PCM) and dust. (Minimal TEM data did not allow for statistical analyses.) The results of the PCM and dust analyses, as well as a discussion of the methods employed, are provided.

Note: The data set used in the following analyses is presented in Appendix B.

cc: Glenn Shaul (w/attachment)

Data Summary

Samples for PCM, f/cc, DUST, mg/m³, and TEM, s/cc were collected at the Lambert-St. Louis International Airport from 10/99 to 05/04. The samples were collected from 36 demolition sites - 7 commercial and 29 residential. Each residential demolition was completed in one day and most commercial sites required more than one day of demolition. At most sites, sampler(s) were placed in both the up- and downwind directions, 3-5 feet off the ground, and approximately 50 to 60 ft from the demolition activities. However, for each sampling day, not all three parameters (response variables-DUST, PCM, and TEM) were sampled, and in some cases samplers were placed in only one direction. The total number of individual sampler measurements for the three response variables is provided in Table A-1.

Table A-1. Number of Response Variable Measurements by Direction and Building Type.

Bldg. Type	Direction	PCM	DUST	TEM
Residential	Up-	42	20	3
	Down-	55	28	2
Commercial	Up-	79	29	2
	Down-	78	27	2

Data Analysis Approach

The data were separated into two groups for independent analysis; the first group was residences and the second was commercial buildings. For each of those groups, two separate analyses were conducted. First, all data were used to compare upwind and downwind values for each response variable (PCM, and DUST). Second, the means of the upwind and downwind measurements (paired means) for each separate building were used and those values were compared. This dual approach was necessitated by the lack of information regarding the sampling design. The rationale for these choices is provided in the following paragraphs.

Paired means were constructed to compensate for the potential bias in sampler locations (not all demolition sites had at least one up- and downwind sampler) and the lack of independence between sampling days (commercial sites had more than one sampling day, therefore sampling days within a commercial site are more correlated than sampling days between sites). Paired means for a site were calculated for those sites that had at least one upwind and one downwind measurement. In cases where there was more than one sampler and/or sampling day, the directional average (upwind average and downwind average) was calculated over all samplers and days. In cases where there was only one sampler in each direction, the individual measurements were used. For the 29 residential sites, there are 25 paired measurements for PCM, 9 paired measurements for DUST, and 2 paired measurements for TEM. For the 7 commercial sites, there are 7 paired measurements for PCM, 4 paired measurements for DUST, and one paired measurement for TEM.

Due to the fact there are so few commercial site paired means, the data were also analyzed using the individual sampler measurements referenced in Table A-1. While this may violate the assumption of independent observations, it is believed that the statistical analyses of the individual sampler measurements provide additional insight into the data.

Due to the limited number of TEM observations, no statistical analyses were conducted. In the cases where there are paired measurement for TEM, the values are the same in both directions.

Individual Sampler Measurements: Descriptive Statistics

The descriptive statistics for PCM and DUST are provided in Table A-2. The table provides the minimum and maximum values, mean and median measures of location, and standard deviation measure of scale. The statistics are provided for up- and downwind by building type combination.

Table A-2. Summary Statistics for Upwind and Downwind by Building Type:
Demolition Site Individual Observations

PCM f/cc						
Method		Minimum	Median	Mean	Maximum	Std. Dev.
Residential	Up (n = 42)	0.0025	0.0077	0.0246	0.3231	0.0558
	Down (n = 55)	0.0018	0.0079	0.0156	0.1147	0.0211
Commercial	Up (n = 79)	0.0020	0.0049	0.0148	0.5541	0.0625
	Down (n = 78)	0.0025	0.0054	0.0157	0.2574	0.0380
DUST mg/m ³						
Method		Minimum	Median	Mean	Maximum	Std. Dev.
Residential	Up (n = 20)	0.0100	0.0725	0.0770	0.2730	0.0626
	Down (n = 28)	0.0036	0.0770	0.0891	0.3350	0.0826
Commercial	Up (n = 29)	0.0100	0.0690	0.4735	10.1600*	1.8681
	Down (n = 27)	0.0090	0.0634	0.2934	3.7070	0.7245

*With the outlier 10.1600, the Mean = 0.1277, Maximum = 0.6190, Std. Dev. = 0.1521.

The large standard deviation for the DUST method in the upwind direction for commercial buildings is a result of one anomalous value from Parcel 11969,11351 Long Road; 11417, 11419 and 11421 Ann Mar, demolished on 10/16/2002. This anomalous value, 10.1600 mg/m³, has no assignable cause. Since omitting this value creates a conservative bias, the decision was made to omit the observation from further statistical analyses.

The individual PCM values are plotted in Figures A-1 and A-2 by building type and direction; the individual DUST values are plotted in Figures A-3 and A-4 by building type and direction. The figures include histograms, scatter plots, and box plots (details on how to interpret a box plot are included at the end of this attachment). The plots are used to check for any values that may fall outside the main body of the data and to evaluate the shape of the distributions; both are important in assessing appropriate statistical methods for inference. All plots display a positively skewed distribution; this is also seen in the measures of location where the mean >> median. There does not appear to be any outliers in the PCM data. There is one downwind DUST value, 3.707 mg/m³, for a commercial site at Parcel 11868, 4620 N. Lindbergh, demolished on 01/15/2002, that is outside the main body of the data (see Figure A-4). There is no assignable cause for the value so the decision was made to include the value in all statistical analyses.

Individual Sampler Measurements: Inferential Statistics

The shape of the distributions rule out any inferential method that assumes normality (unless the data are transformed to achieve a more bell shape/normal distribution), therefore a nonparametric method, the Wilcoxon Signed Rank test, was used to evaluate up- versus downwind differences. The null hypothesis of the Wilcoxon Signed Rank test is that the median of the differences is zero. The results of the Wilcoxon Signed Rank test are provided in Table A-3 for the individual observations. For all four tests that were conducted, the null hypothesis is not rejected; the smallest p-value is 0.3838.

Table A-3. Results of the Kolmogorov-Smirnov GOF Test and Wilcoxon Sign Rank Test by Building Type: Upwind versus Downwind - Demolition Site Individual Observations

		KS GOF Test		Wilcoxon Signed Rank Test	
Method		Test Statistic	p-value of the Test Statistic	Test Statistic	p-value of the Test Statistic
Residential	PCM	0.0881	0.9623	0.2263	0.8210
	DUST	0.1017	0.9975	-0.3360	0.7369

Commercial	PCM	0.1334	0.4039	-0.8710	0.3838
	DUST	0.1534	0.8439	-0.1011	0.9195

An additional method to compare the up- and down-wind distributions is to conduct a goodness-of-fit (GOF) test. The null hypothesis of a goodness of fit is that the empirical distribution follows the same name brand distribution (for example, lognormal) or that two empirical distributions are the same. In this case, the two empirical distributions are the up- and downwind measurements. The Kolmogorov-Smirnov (K-S) GOF tests was conducted by building type. A description of the K-S GOF test is provided at the end of this attachment. The results of the K-S GOF tests are provided in Table A-3 for the individual observations. The empirical cumulative distributions used in the K-S GOF tests are displayed by building type in Figure A-5 for PMC and Figure A-6 DUST. For all four tests that were conducted, the null hypothesis is not rejected; the smallest p-value is 0.4039.

Site Paired Means: Descriptive Statistics

The descriptive statistics for the paired means and the mean differences (upwind – downwind) are provided in Table A-4.

Table A-4. Summary Statistics for Upwind and Downwind by Building Type:
Demolition Site Paired Means

PCM f/cc						
Method		Minimum	Median	Mean	Maximum	Std. Dev.
Residential (n = 25)	Up	0.0031	0.0086	0.0163	0.1028	0.0228
	Down	0.0031	0.0097	0.0191	0.0865	0.0210
	Diff	-0.0731	-0.0010	-0.0028	0.0936	0.0296
Commercial (n = 9)	Up	0.0027	0.0061	0.0170	0.0716	0.0248
	Down	0.0027	0.0062	0.0178	0.0710	0.0246
	Diff	-0.0042	-0.0001	-0.0008	0.0006	0.0018
DUST mg/m ³						
Method		Minimum	Median	Mean	Maximum	Std. Dev.
Commercial (n = 7)	Up	0.0100	0.0615	0.0626	0.1310	0.0434

Commercial (n = 4)	Down	0.0043	0.0825	0.0840	0.1805	0.0562
	Diff	-0.1555	0.0000	-0.0215	0.0057	0.0611
	Up	0.0310	0.0942	0.0954	0.1351	0.0595
	Down	0.0420	0.1210	0.1340	0.2521	0.0874
	Diff	-0.1260	-0.0301	-0.0387	0.0316	0.0669

The mean differences (upwind – downwind) for PCM and DUST are plotted in Figures A-7 and A-8, respectively. The figures include histograms, normal quantile-quantile plots, and box plots (a definition of a normal quantile-quantile plot is provided at the end of this attachment). Although the differences are not bell-shaped, there does not appear to be any anomalous values. For both variables, the mean < median, an indication there are more paired means where the downwind value > upwind value. This is also reflected in the median of the PCM differences, -0.0010 f/cm³, and the median of the DUST differences, -0.0006 mg/m³.

Site Paired Means: Inferential Statistics

A paired Wilcoxon Signed Rank test was conducted by building type for all paired means except for DUST for the commercial site due to the small sample size of four. The results of the paired Wilcoxon Signed Rank tests are provided in Table A-5 for the paired means. For all three tests that were conducted, the null hypothesis is not rejected; the smallest p-value is 0.2418.

Table A-5. Results of the Kolmogorov-Smirnov GOF Test and Wilcoxon Sign Rank Test by Building Type: Upwind versus Downwind - Demolition Site Paired Means

		KS GOF Test		Wilcoxon Signed Rank Test	
Method		Test Statistic	p-value of the Test Statistic	Test Statistic	p-value of the Test Statistic
Residential	PCM	0.1923	0.7327	-1.1700	0.2418
	DUST	0.2222	0.9895	-0.1793	0.8577
Commercial	PCM	0.2000	0.9945	-0.6786	0.4974
	DUST*				

*Test not conducted due to sample size of 4.

The Kolmogorov-Smirnov (K-S) GOF tests was also conducted by building type for paired means, with the exception of the response variable DUST for commercial buildings. The results

of the K-S GOF tests are provided in Table A-5. The empirical cumulative distributions used in the K-S GOF tests are displayed by building type in Figure A-9 for PCM and Figure A-10 for DUST. For all three tests that were conducted, the null hypothesis is not rejected; the smallest p-value is 0.7327.

Figure A-1. Individual PCM f/cc Values for Up- and Downwind Residential Demolitions

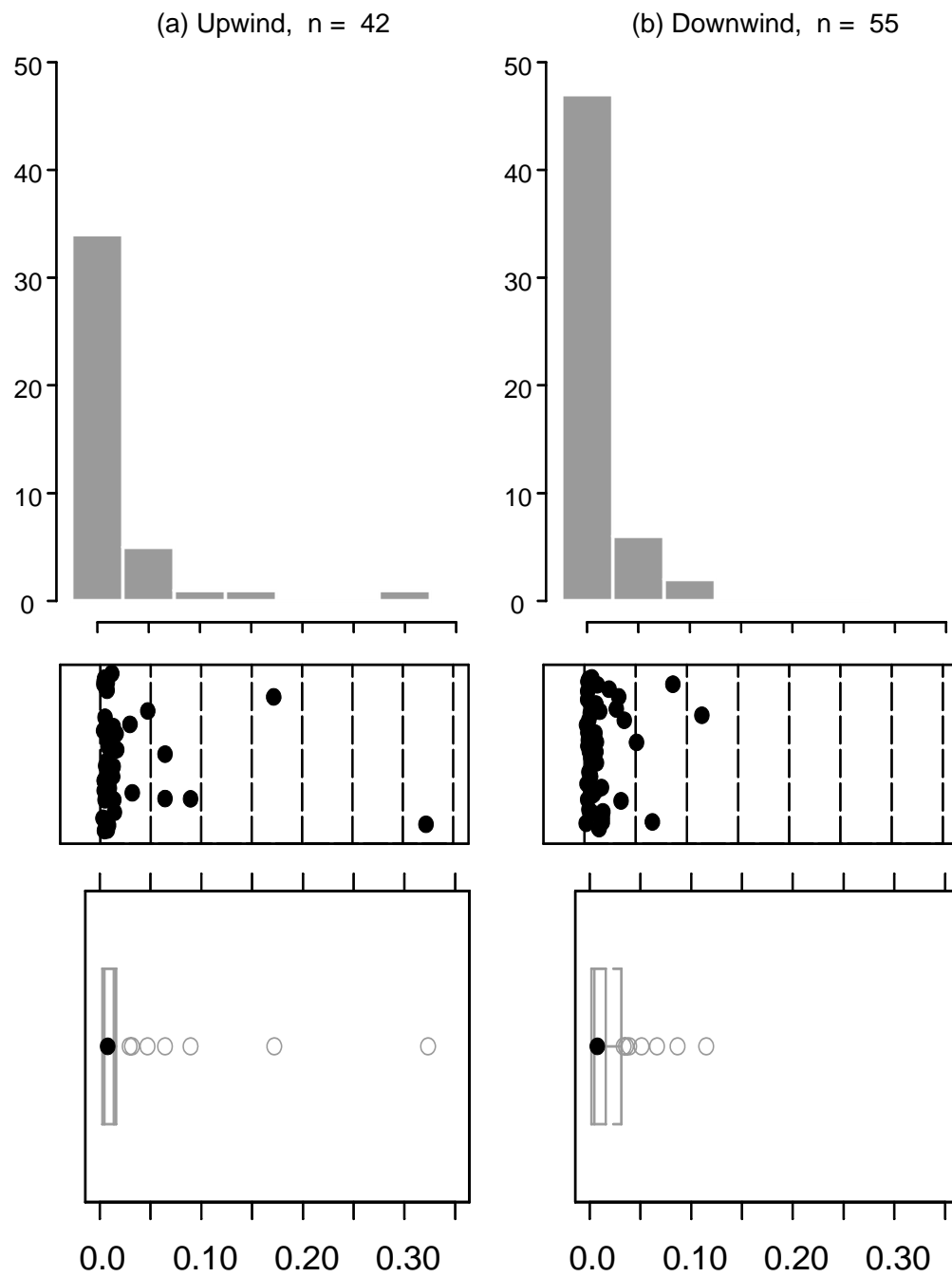


Figure A-2. Individual PCM f/cc Values for Up- and Downwind Commercial Demolitions

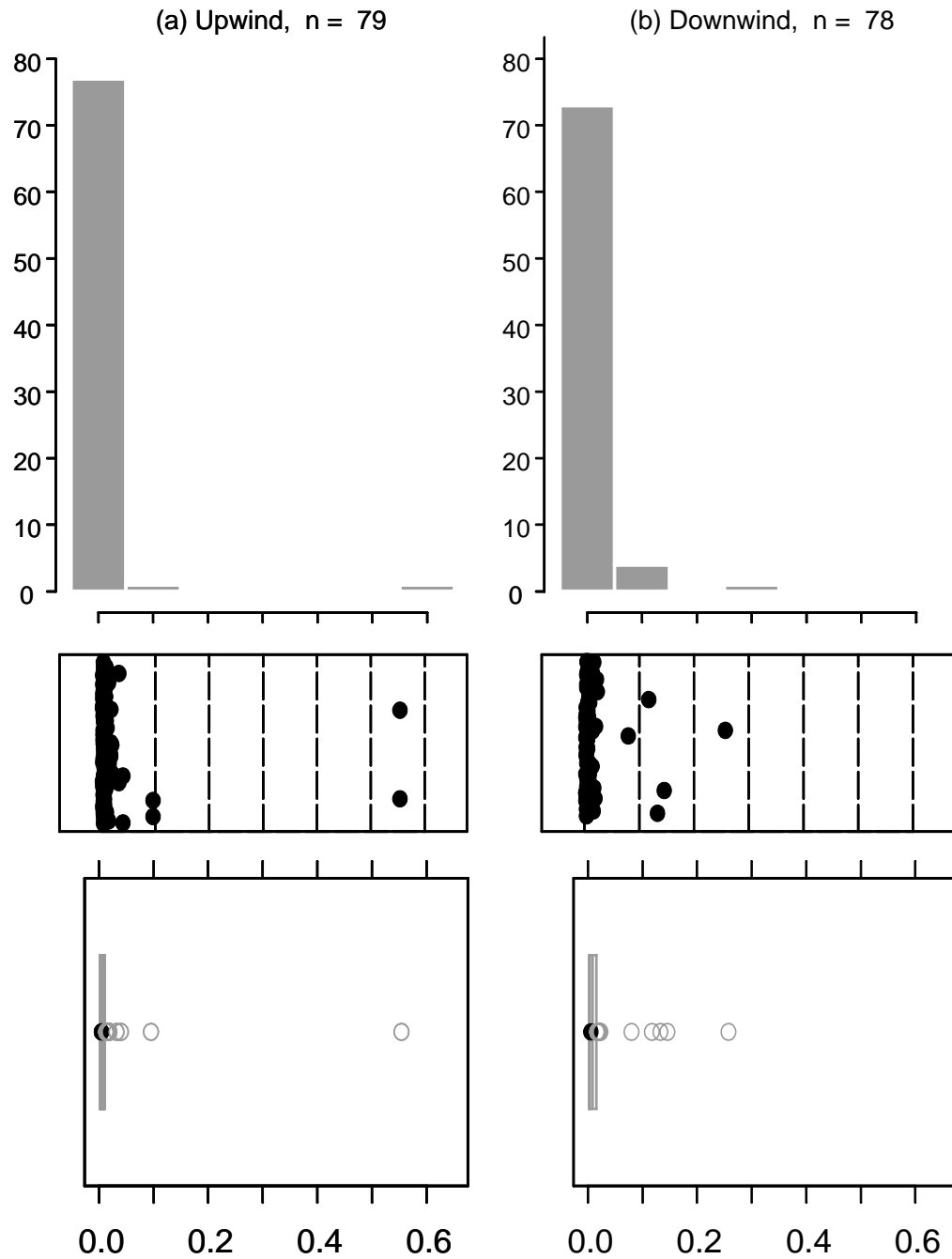


Figure A-3. Individual DUST mg/m^3 Values for Up- and Downwind Residential Demolitions

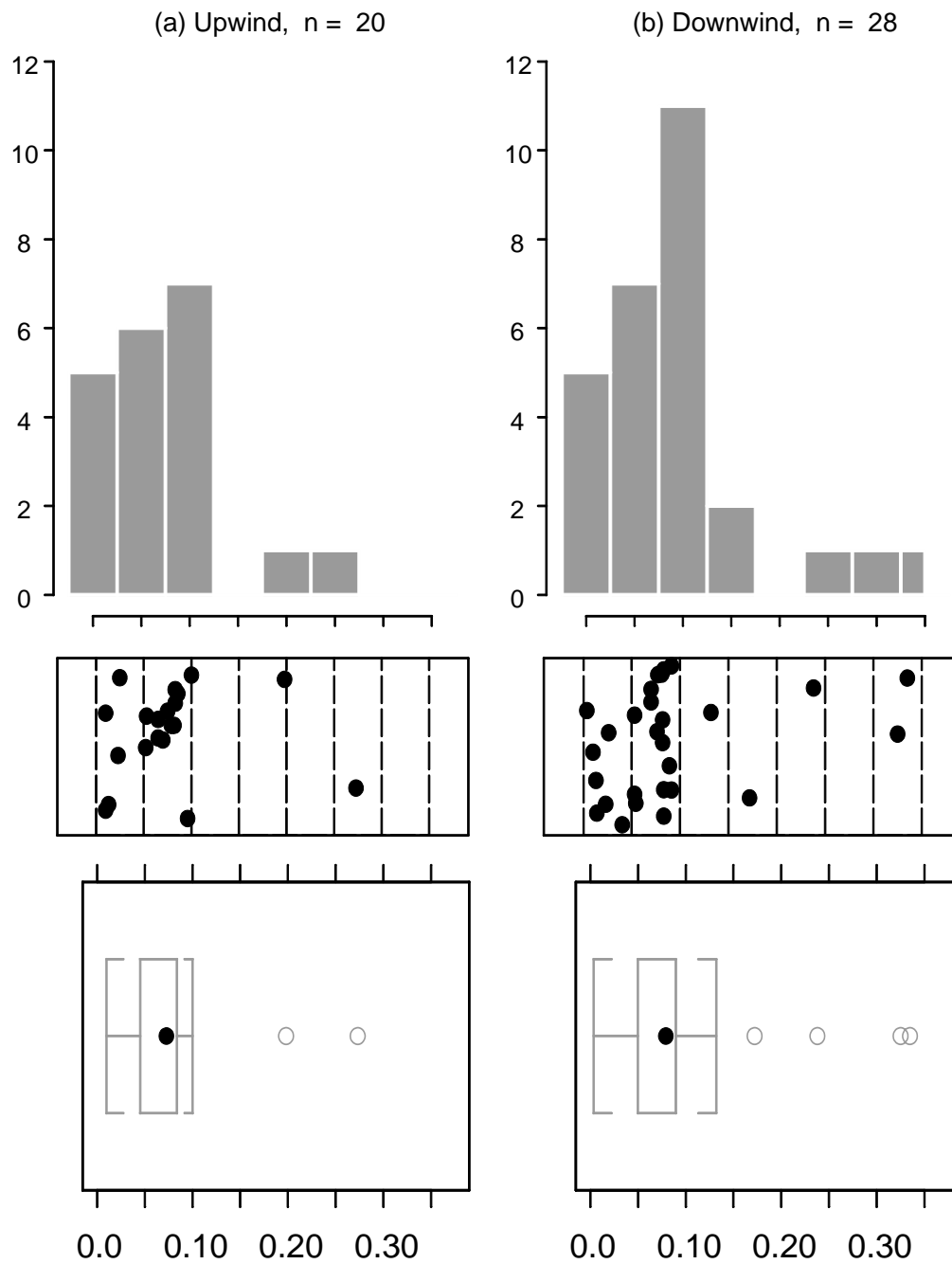
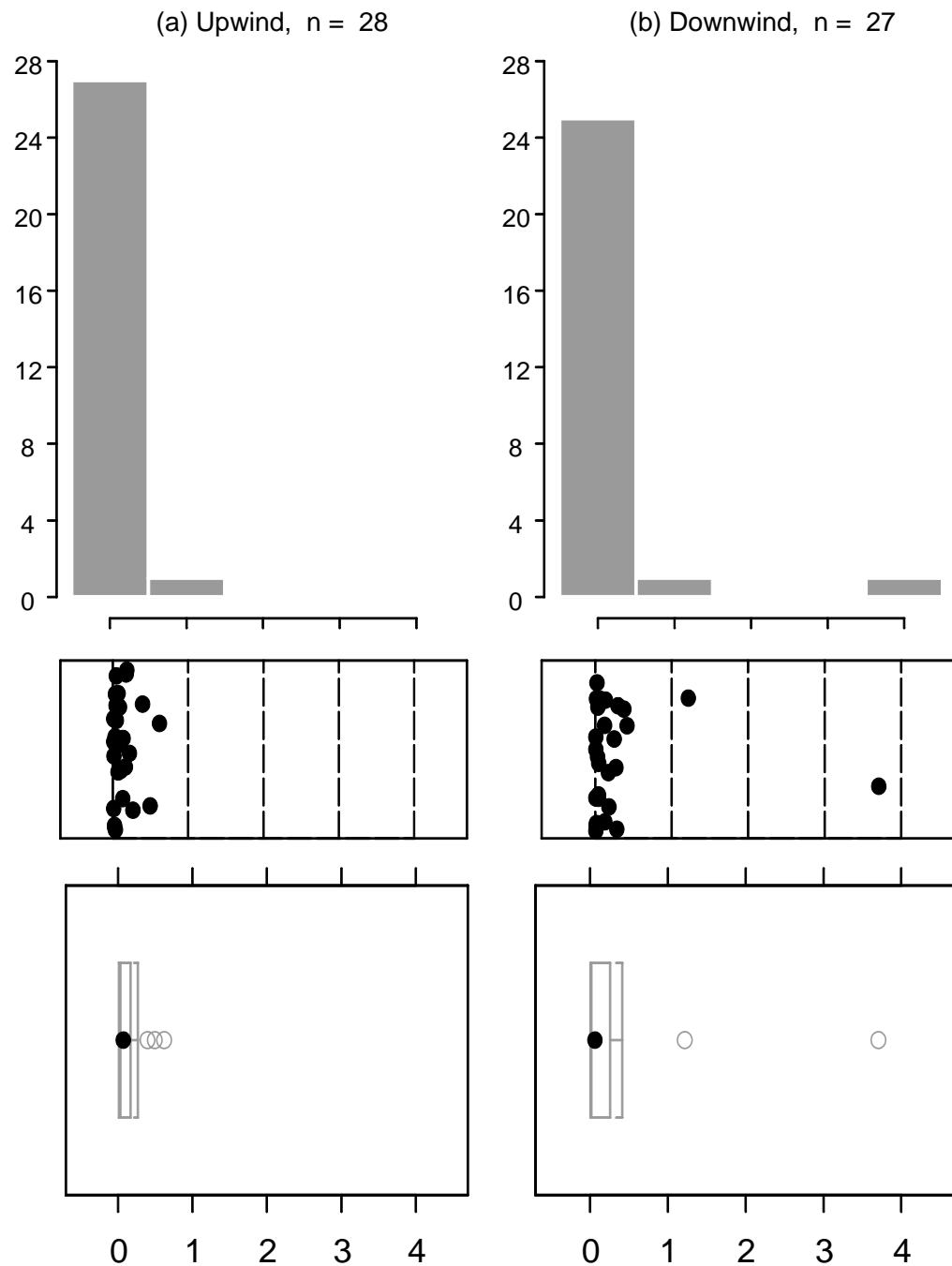


Figure A-4. Individual DUST mg/m^3 Values for Up- and Downwind Commercial Demolitions



Note: Does not include observation from Parcel 11969, 11351 Long Road; 11417, 11419 and 11421 Ann Mar, demolished on 10/16/2002, anomalous value, 10.1600 mg/m^3 .

Figure A-5. CDFs of the Residential and Commercial Up- and Downwind PCM f/cc Distributions for Individual Observations.

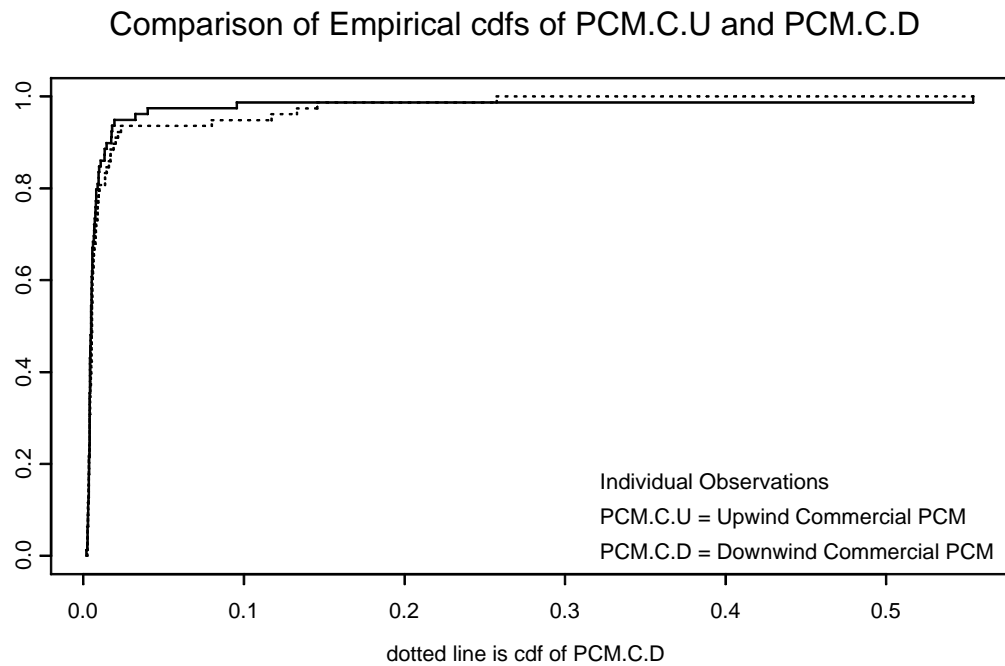
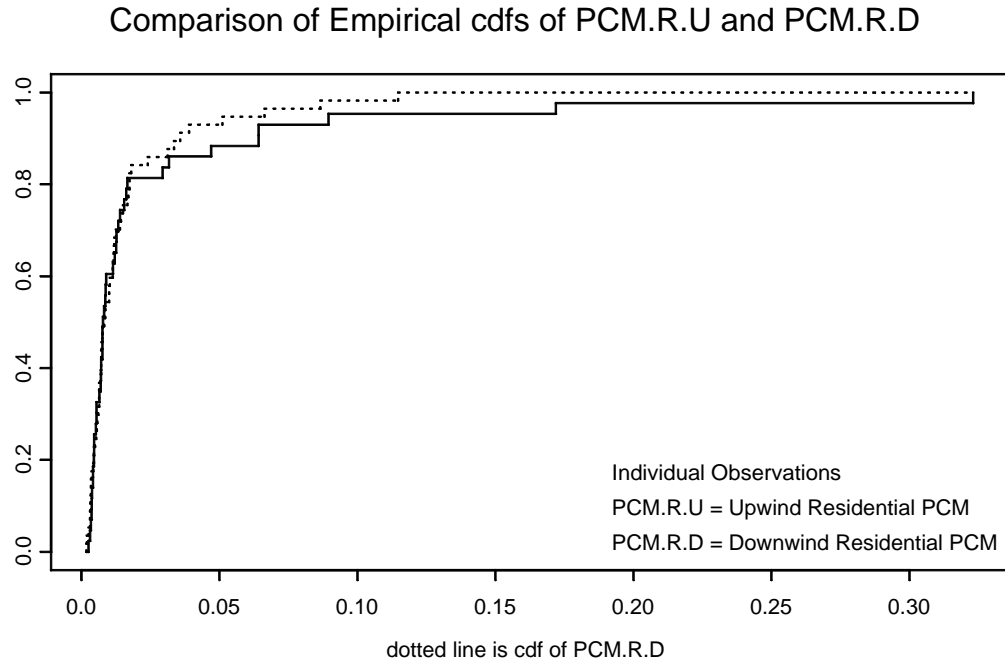


Figure A-6. CDFs of the Residential and Commercial Up- and Downwind DUST mg/m³ Distributions for Individual Observations

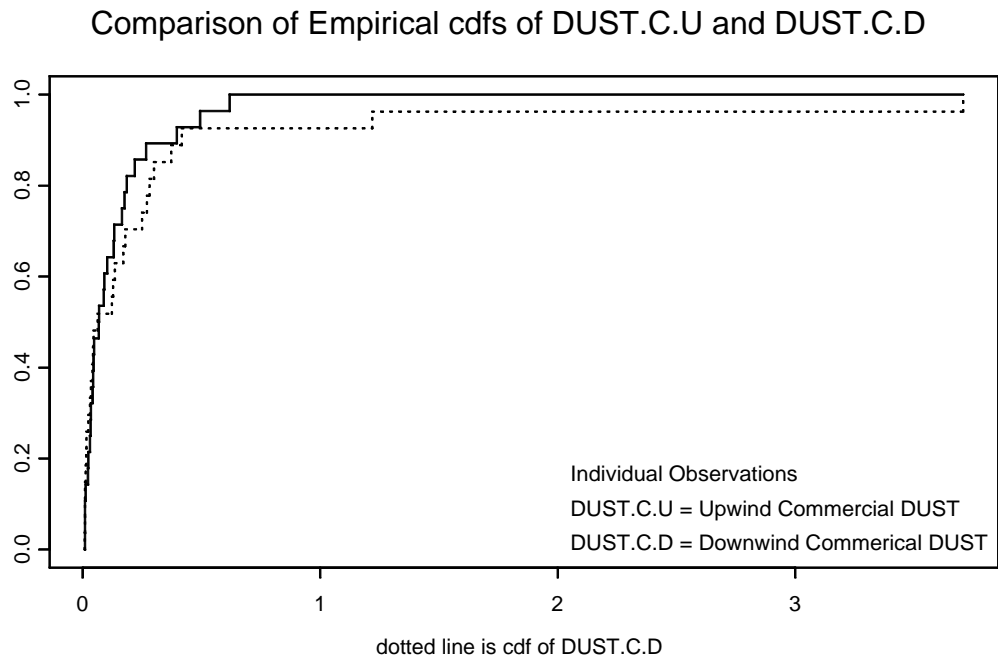
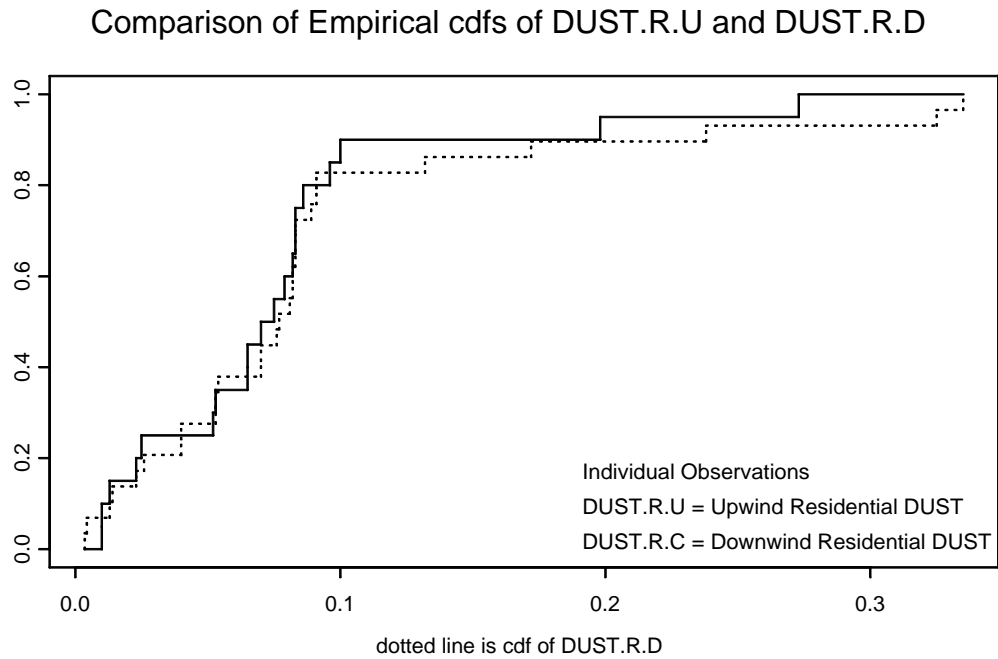


Figure A-7. Mean Differences (Upwind – Downwind) for PCM f/cc Building Types Combined:
(A) Histogram, (B) Normal Quantile-Quantile Plot, and (C) Box Plot

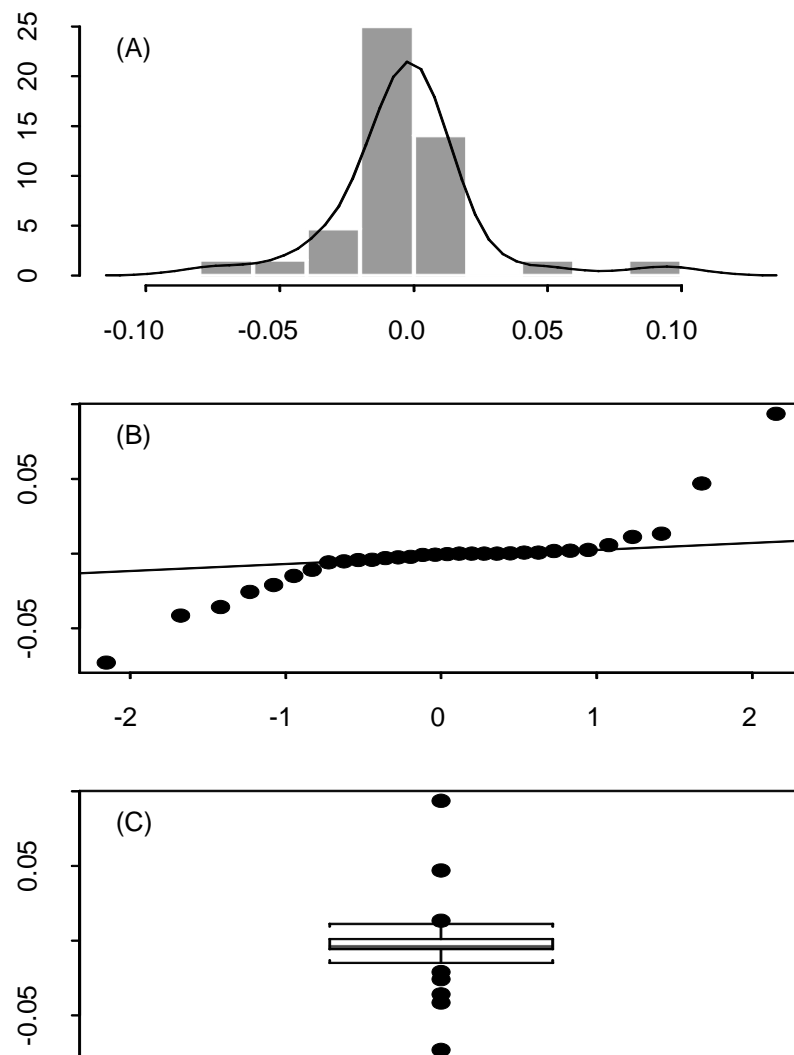


Figure A-8. Mean Differences (upwind – downwind) for DUST mg/m³ Building Types Combined:

(A) Histogram, (B) Normal Quantile-Quantile Plot, and (C) Box Plot

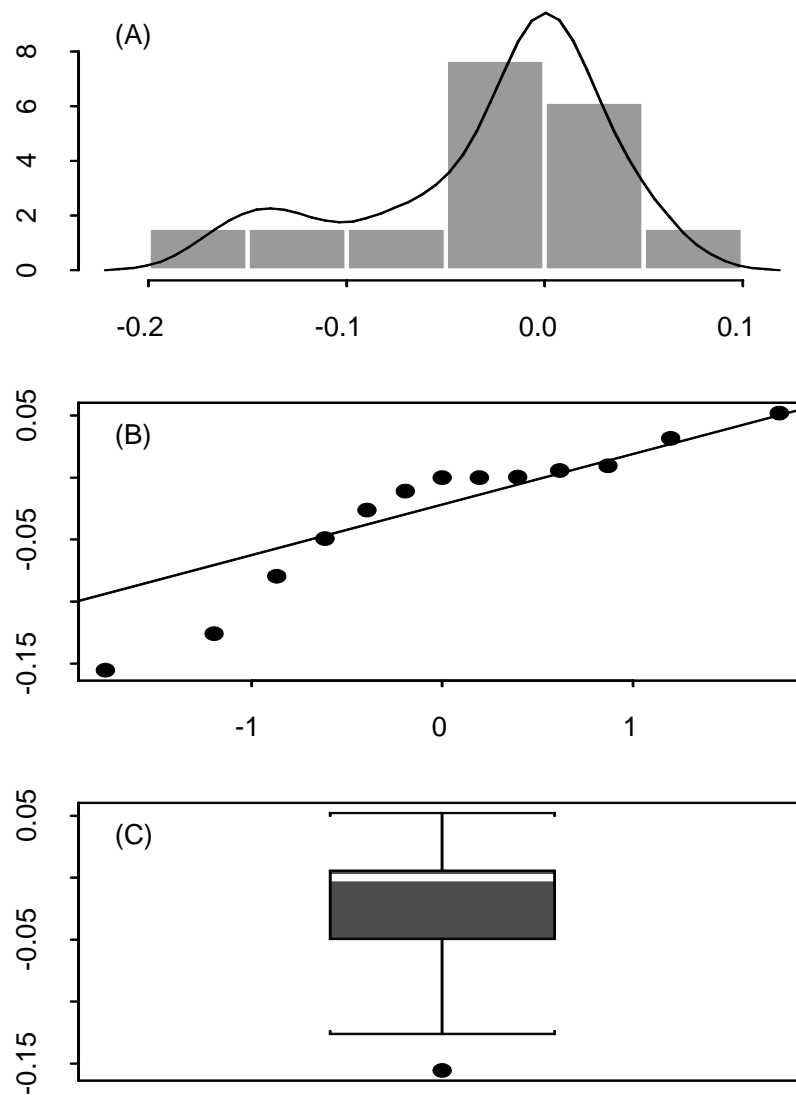


Figure A-9. CDFs of the Residential and Commercial Upwind and Downwind PCM f/cc Distributions for Site Means

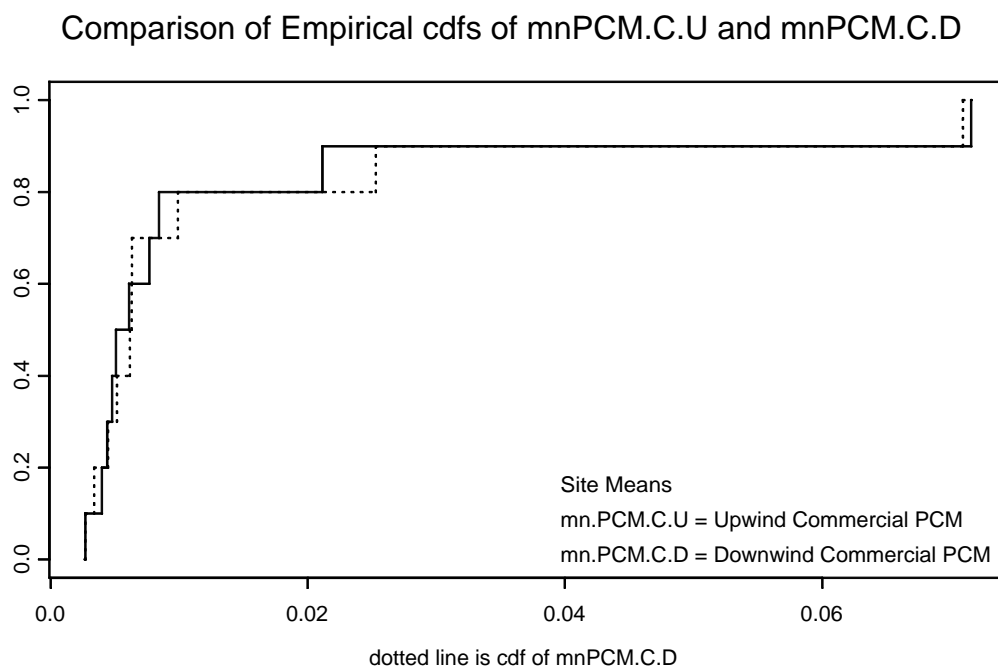
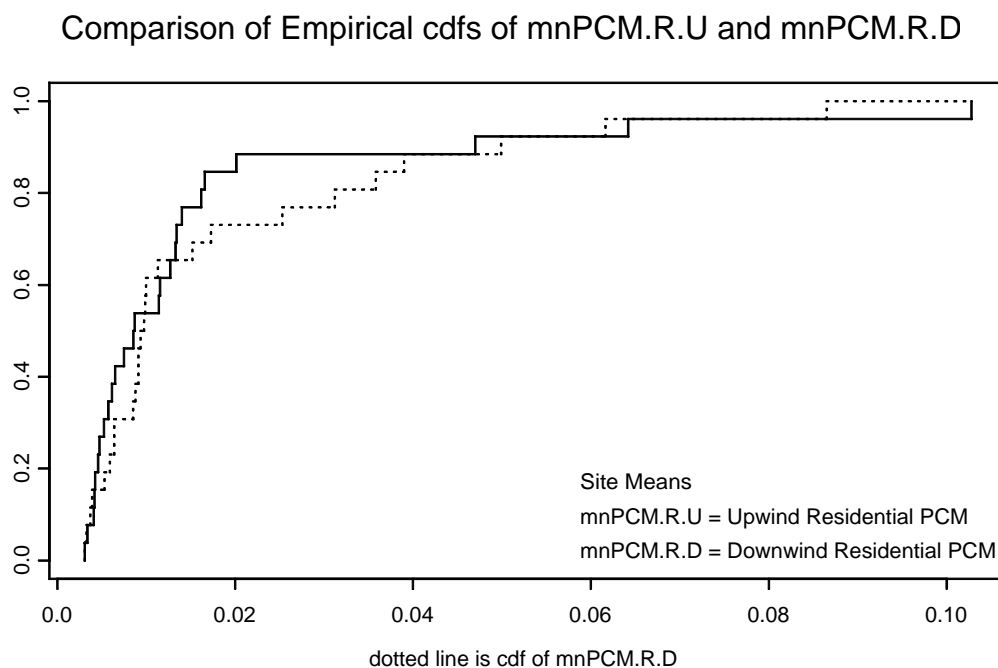
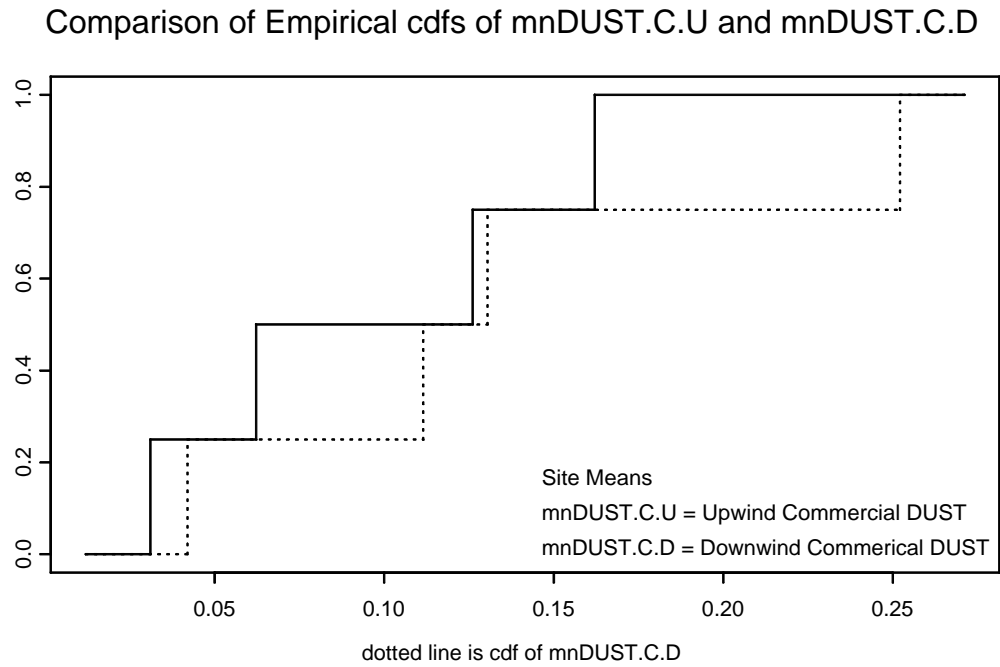
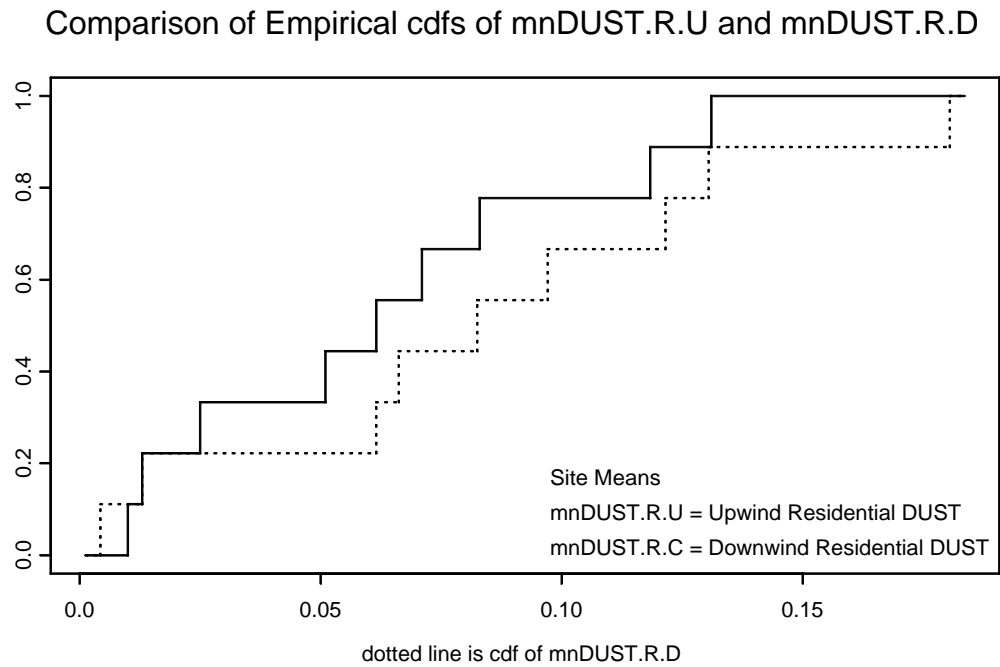


Figure A-10. CDFs of the Residential and Commercial Up- and Downwind DUST mg/m^3 Distributions for Site Means



Description of Statistical Analyses and Figure Acronyms

Box Plot

A box plot is a rectangle, the top and bottom of the rectangle represent the upper and lower quartiles of the data, the filled circle or white horizontal line within the rectangle represents the median. Lines, in the shape of a “T”, extend from the box to the nearest value not beyond a *standard span* from the quartiles. These lines are often referred to as whiskers. Values beyond the end of the whiskers are drawn individually, unfilled circles or filled circles.

The standard span is $1.5 \cdot \text{Inter-Quartile Range (IQR)}$, where the *upper quartile* is the 75th quantile, $Q(.75)$, the *lower quartile* is the 25th quantile, $Q(.25)$ and the $IQR = Q(.75) - Q(.25)$.

The box plot of a set of observations that are normally distributed will be symmetric with the median in the center of the box.

Histogram

A histogram partitions the range of the data into several nonoverlapping intervals of equal length, called bins, and counts the number of observations in each bin. The number of counts in each bin can be displayed on a density scale, where the y-axis represents the probability; or a nondensity or frequency scale, where the y-axis represents the bin counts. The histogram is completely determined by two parameters, the *bin width* and the *bin origin*.

The histogram of a set of observations that are normally distributed will appear unimodal and symmetric.

Quantile-Quantile Plot

A normal quantile-quantile plot (Q-Q plot) is obtained by plotting the quantiles of the observed data against the corresponding quantiles of the normal distribution. If the quantiles of the empirical distribution and the quantiles of the normal distribution, fall on a straight line then the distributions are similar.

Kolmogorov-Smirnov GOF Test

Goodness-of-fit tests (GOF) involve the null hypothesis that a given random variable follows a stated probability law $F(x)$. Empirical distribution function (EDF) GOF tests measure the discrepancy between the EDF and a given distribution function, and are used for testing the fit of the sample to the distribution. The distribution may be completely specified or may contain parameters which must be estimated from the sample.

The EDF is $F_n(y)$ defined by

$$F_n(y) = \frac{\text{\# of observations } \leq y}{n} ; -\infty < y < \infty$$

For any x , $F_n(y)$ records the proportion of observations less than or equal to x . $F_n(y)$ is used to estimate $F(y)$. In fact it is a consistent estimator of $F(y)$, since as $n \rightarrow \infty$, $|F_n(y) - F(y)|$ decreases to zero with probability one.

The EDF is just another way to describe the distribution of a random variable. The EDF is the empirical *cumulative relative frequency* which is a simple example of a *cumulative distribution function* (CDF).

Definitions . . .

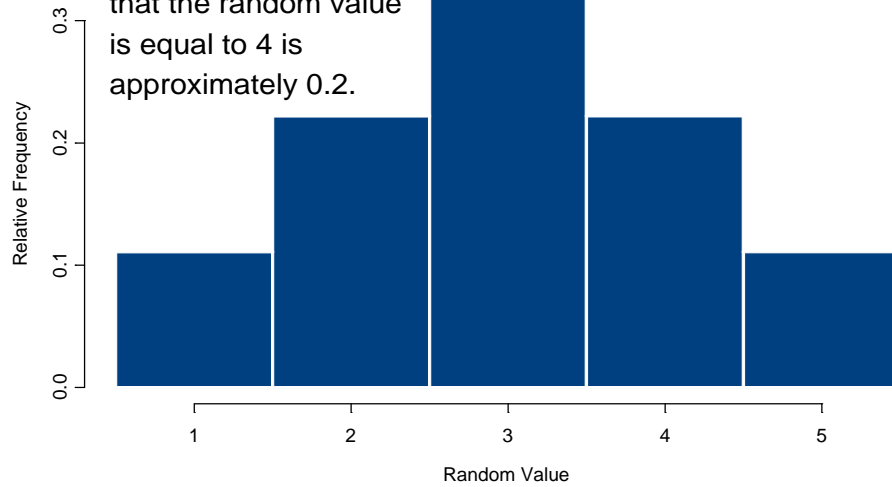
1. *Frequency* is the number of observations in a particular class. The relative frequency is frequency expressed as a proportion or percent of the total frequency. This simplest example of a probability distribution function (PDF) is the relative frequency histogram.
2. The cumulative frequency (CDF) is the number of observation less than or equal to the class value. The relative cumulative frequency is cumulative frequency expressed as a proportion or percent of the total frequency.

Examples of a PDF and CDF are provided on the next page.

Examples of a Simple PDF and CDF.

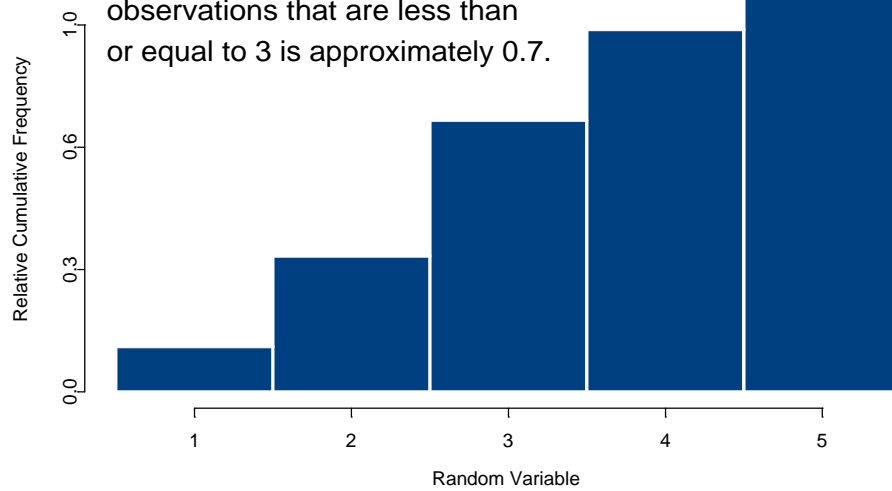
Interpretation:

For example, the probability that the random value is equal to 4 is approximately 0.2.



Interpretation:

For example, the proportion of observations that are less than or equal to 3 is approximately 0.7.



EDF tests are based on the largest vertical difference between $F_n(y)$ and $F(y)$. They are divided into two classes, *supremum* and *quadratic*.

Supremum:

The most well-known EDF test statistic is D . It was introduced by Kolmogorov in 1933. This test is referred to as the Kolmogorov-Smirnov Test or the KS Test. D is the largest of two vertical differences:

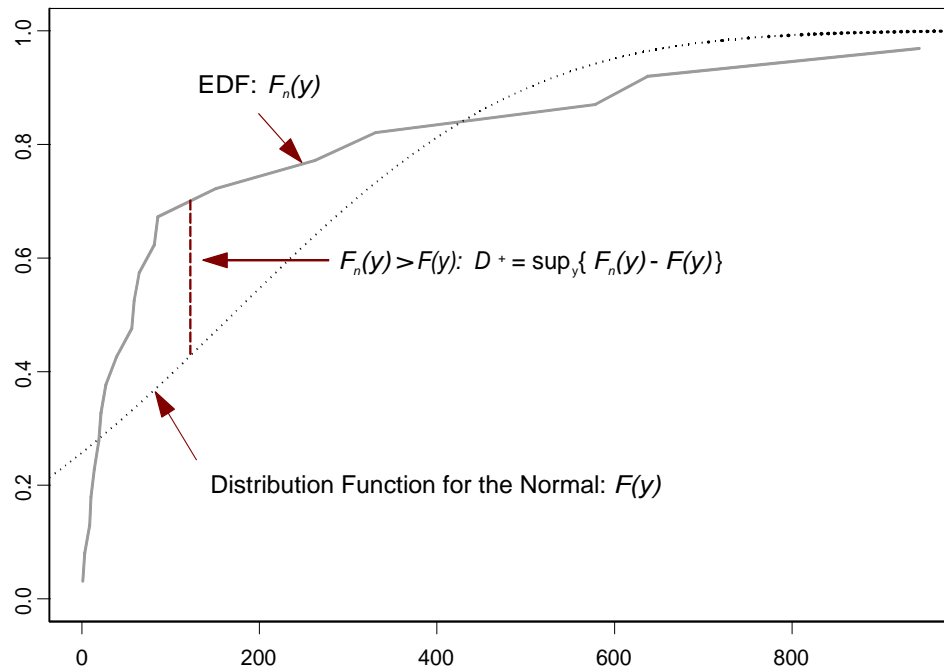
1. $F_n(y) > F(y)$, $D^+ = \sup_y \{ F_n(y) - F(y) \}$, and
2. $F_n(y) < F(y)$, $D^- = \sup_y \{ F(y) - F_n(y) \}$.

Combined we have,

$$D = \sup_y |F_n(y) - F(y)| = \max \{ D^+, D^- \}.$$

Graphical Representation of the KS Test

Empirical and Hypothesized Normal CDfs



Graphical Representation of the KS Test

APPENDIX B - - DATA

Parcel	Address	Bldg	Date	U.PCM	D.PCM	U.TEM	D.TEM	U.DUST	D.DUST
		Type		f/cc	f/cc	s/cc	s/cc	mg/m ³	mg/m ³
10281	4409 Brantwood	R	10/25/99	0.0025	0.0049				
10281	4409 Brantwood	R	10/25/99	0.007	0.0075				
10281	4409 Brantwood	R	10/25/99		0.015				
10245	11917 Tazwell	R	10/26/99	0.0078	0.0053				
10245	11917 Tazwell	R	10/26/99	0.0037	0.0034				
10245	11917 Tazwell	R	10/26/99		0.0031				
10301	12150 Franclar	R	10/27/99	0.0071	0.0032				
10301	12150 Franclar	R	10/27/99	0.0052	0.0025				
10301	12150 Franclar	R	10/27/99		0.0055				
10288	4424 Holmford	R	10/28/99	0.0044	0.051				
10288	4424 Holmford	R	10/28/99	0.0041	0.0069				
10288	4424 Holmford	R	10/28/99		0.018		0.0027		
11316	12650 Grandin	R	11/01/99	0.0155	0.0125	<0.0036	<0.0036		
11316	12650 Grandin	R	11/01/99	0.0076	0.0018				
11316	12650 Grandin	R	11/01/99		0.0034				
11513	12622 Weskan	R	11/02/99	0.0069	0.0044				
11513	12622 Weskan	R	11/02/99	0.0036	0.0044				
11513	12622 Weskan	R	11/02/99		0.0071				
11452	12647 Woodford Way	R	02/14/00	<0.012	0.0143				
11452	12647 Woodford Way	R	02/14/00	0.3231	<0.0117	0.0163			
11452	12647 Woodford Way	R	02/14/00	0.1719	<0.0019	<0.005			
11452	12647 Woodford Way	R	02/14/00	0.0895	<0.0042				
11452	12647 Woodford Way	R	02/14/00	0.0076	0.0061				
11452	12647 Woodford Way	R	02/14/00	0.0126	<0.0166				
10649	4396 Bonfils	R	03/03/00					<0.1	0.091
10649	4396 Bonfils	R	03/03/00					<0.065	0.132
10649	4396 Bonfils	R	03/03/00					<0.086	0.172
10649	4396 Bonfils	R	03/03/00					0.273	0.091
11218	4247 Galatan	R	03/08/00					<0.096	<0.089
11218	4247 Galatan	R	03/08/00		0.0036			<0.065	0.325
11218	4247 Galatan	R	03/08/00					<0.052	<0.054
11218	4247 Galatan	R	03/08/00	0.0127	0.014				
11924	12756 Marburn	R	03/15/00		0.0113			<0.082	<0.082
11924	12756 Marburn	R	03/15/00					0.198	0.082
11924	12756 Marburn	R	03/15/00					<0.075	<0.04
11924	12756 Marburn	R	03/15/00						<0.04
11924	12756 Marburn	R	03/15/00						<0.076
11924	12756 Marburn	R	03/15/00						<0.077
11924	12756 Marburn	R	03/15/00	0.0046	0.0085				
10604	12305 Winnsboro	R	03/16/00					<0.083	<0.083

10604	12305 Winnsboro	R	03/16/00					<0.083	<0.081
10604	12305 Winnsboro	R	03/16/00						<0.083
10604	12305 Winnsboro	R	03/16/00						<0.083
10669	12346 Winnsboro	R	03/17/00	0.0041	0.0043			<0.01	<0.01
10669	12346 Winnsboro	R	03/17/00						<0.01
10669	12346 Winnsboro	R	03/17/00					<0.01	
10653	4408 Bonfils	R	03/21/00		0.0057			<0.025	0.335
10653	4408 Bonfils	R	03/21/00		0.0071				<0.026
10802	14800 Dorrance	R	03/21/00	0.014	0.0335			<0.07	<0.07
10802	14800 Dorrance	R	03/21/00		0.0663			<0.053	<0.07
10802	14800 Dorrance	R	03/21/00						<0.053
10802	14800 Dorrance	R	03/21/00						<0.053
10414	12165 Haldane	R	03/22/00	0.0162	0.0312			<0.079	0.238
10414	12165 Haldane	R	03/22/00					<0.023	<0.023
10793	14822 Dorrance	R	03/22/00	<0.0031	0.0031				
11652	4276 Chartley	R	02/01/01	0.0034	0.0064				
10378	12050 Rosedon	R	04/25/01	0.0166	0.0033				
10522	12188 Dunsinane	R	08/03/01	0.0133	0.039				
10447	4250 Pont	R	09/06/01	0.0087	0.0113				
11643	12790 Woodford Way	R	10/01/01	<0.0054	0.0865				
11643	12790 Woodford Way	R	10/01/01	<0.0054					
11643	12790 Woodford Way	R	10/01/01	0.0294					
10278	4408 Brantwood	R	10/24/01	0.0089	0.0116				
10278	4408 Brantwood	R	10/24/01	0.0082	0.0071				
11875	4609-4613 Parc Orleans	C	01/25/02	<0.004	0.004				
11875	4609-4613 Parc Orleans	C	01/29/02	0.0056	0.0028				
11875	4501-4507 Parc Orleans	C	02/04/02	0.0039	0.0051				
11875	4501-4507 Parc Orleans	C	02/07/02	0.0039	0.0056				
11875	4501-4507 Parc Orleans	C	02/08/02	0.0054	0.0048				
11875	4617-4623 Parc Orleans	C	02/11/02	0.0041	0.0045				
11875	4617-4623 Parc Orleans	C	02/11/02	0.0131	0.0101				
11875	4617-4623 Parc Orleans	C	02/12/02	0.008	<0.0041				
11875	4602 Parc Orleans	C	02/12/02	0.0051	0.0063				
11868	4680 N Lindberg	C	01/11/02	0.0179	0.08				
11868	4680 N Lindberg	C	01/11/02	0.0145	0.0136				
11868	4680 N Lindberg	C	01/11/02					0.176	0.271
11868	4680 N Lindberg	C	01/14/02	0.0077	0.1331				
11868	4680 N Lindberg	C	01/14/02	0.0324					
11868	4680 N Lindberg	C	01/14/02	0.0174					
11868	4680 N Lindberg	C	01/14/02					0.042	1.219
11868	4680 N Lindberg	C	01/15/02	0.0089	0.2574				

11868	4680 N Lindberg	C	01/15/02					0.091	0.25
11868	4680 N Lindberg	C	01/16/02	0.0401	0.0202				
11868	4680 N Lindberg	C	01/16/02					0.396	0.031
11868	4680 N Lindberg	C	02/04/02					0.045	0.015
11868	4680 N Lindberg	C	02/05/02					0.495	0.043
11868	4680 N Lindberg	C	02/06/02		0.0216			0.13	
11868	4680 N Lindberg	C	02/06/02		0.0056			0.022	
11868	4680 N Lindberg	C	02/07/02	0.0033	0.009				
11868	4680 N Lindberg	C	02/07/02					0.046	0.3
11868	4680 N Lindberg	C	02/08/02					<0.013	0.128
11868	4680 N Lindberg	C	02/11/02	0.0195	0.0234				
11868	4680 N Lindberg	C	02/11/02					0.024	0.012
11868	4680 N Lindberg	C	02/12/02	0.5541	0.1457				
11868	4680 N Lindberg	C	02/15/02					0.033	3.707
10433	4384 Holmford	R	02/18/02	<0.0086	0.1147				
10433	4384 Holmford	R	02/18/02	0.0317	0.0086				
11827	4575 N Lindberg	C	03/08/02	0.0029	0.0028				
11827	4575 N Lindberg	C	03/08/02	0.0043	0.0033				
11827	4575 N Lindberg	C	03/08/02	0.002					
11827	4575 N Lindberg	C	03/08/02	0.0037					
11827	4575 N Lindberg	C	03/11/02	<0.0041	0.0042				
11827	4575 N Lindberg	C	03/11/02	0.0056	0.0043				
11827	4575 N Lindberg	C	03/11/02	<0.0044					
11827	4575 N Lindberg	C	03/11/02	0.0042					
11827	4575 N Lindberg	C	03/12/02	0.0038	<0.0035				
11827	4575 N Lindberg	C	03/12/02	0.0041	0.0039				
11827	4575 N Lindberg	C	03/12/02	0.0034					
11827	4575 N Lindberg	C	03/12/02	0.0049					
11827	4575 N Lindberg	C	03/13/02	0.0035	0.0069				
11827	4575 N Lindberg	C	03/13/02	0.0039	0.0035				
11827	4575 N Lindberg	C	03/13/02	0.0035	0.0056				
11827	4575 N Lindberg	C	03/13/02	0.0041	<0.0039				
11827	4575 N Lindberg	C	03/14/02	0.0045	0.0064				
11827	4575 N Lindberg	C	03/14/02	0.006	<0.0025				
11827	4575 N Lindberg	C	03/14/02	<0.0025	0.0058				
11827	4575 N Lindberg	C	03/14/02	0.0041					
11827	4575 N Lindberg	C	03/15/02	0.0029	0.0053				
11827	4575 N Lindberg	C	03/15/02	0.0049	0.0029				
11827	4575 N Lindberg	C	03/15/02		0.0029				
11827	4575 N Lindberg	C	03/15/02		0.0032				
11827	4575 N Lindberg	C	03/18/02	0.0037	0.0025				
11827	4575 N Lindberg	C	03/18/02	0.0046	0.0033				
11827	4575 N Lindberg	C	03/18/02	0.004	0.0038				
11827	4575 N Lindberg	C	03/18/02		0.006				
11827	4575 N Lindberg	C	03/19/02	<0.0035	0.0039				
11827	4575 N Lindberg	C	03/19/02	<0.0036	<0.0035				
11827	4575 N Lindberg	C	03/19/02	0.0068	<0.0035				

11827	4575 N Lindberg	C	03/19/02		0.0035				
11827	4575 N Lindberg	C	03/20/02	0.004	0.0026				
11827	4575 N Lindberg	C	03/20/02	0.0027	0.0039				
11827	4575 N Lindberg	C	03/20/02	0.004	0.0039				
11827	4575 N Lindberg	C	03/20/02		0.0135				
11827	4575 N Lindberg	C	03/21/02	0.0049	0.0049				
11827	4575 N Lindberg	C	03/21/02	0.0049	0.0055				
11827	4575 N Lindberg	C	03/21/02	0.0039	0.0054				
11827	4575 N Lindberg	C	03/21/02		0.0054				
11827	4575 N Lindberg	C	03/22/02	0.0031	0.005				
11827	4575 N Lindberg	C	03/22/02	0.0031	0.0054				
11827	4575 N Lindberg	C	03/22/02	<0.0038	0.0049				
10476	4286 Pont	R	05/22/02	0.047	0.0358				
10828	12840 Hollister	R	07/10/02	0.0114	0.0118				
10828	12840 Hollister	R	07/10/02		0.0077				
11890	11633 Natural Bridge	C	08/26/02	0.0134	0.0169			0.619	0.046
11890	11633 Natural Bridge	C	08/26/02	0.0108	0.0159			0.035	0.035
11890	11633 Natural Bridge	C	08/27/02	0.0078	0.017				
11890	11633 Natural Bridge	C	08/27/02					0.069	0.0634
11890	11633 Natural Bridge	C	08/28/02	<0.004	0.0055				
11890	11633 Natural Bridge	C	08/28/02					0.089	0.282
11890	11633 Natural Bridge	C	08/29/02	0.0051	0.0043				
11890	11633 Natural Bridge	C	08/29/02					0.048	0.016
11890	11633 Natural Bridge	C	08/30/02	0.0095	0.0075				
11890	11633 Natural Bridge	C	08/30/02					0.133	0.01
11890	11633 Natural Bridge	C	09/03/02	0.0074	0.0097				
11890	11633 Natural Bridge	C	09/03/02					0.104	0.123
11890	11633 Natural Bridge	C	09/04/02	0.0071	0.0087				
11890	11633 Natural Bridge	C	09/04/02					0.068	0.136
11890	11633 Natural Bridge	C	09/05/02	0.0049	0.008				
11890	11633 Natural Bridge	C	09/05/02					0.186	0.171
11890	11633 Natural Bridge	C	09/06/02	0.0081	0.0077				
11890	11633 Natural Bridge	C	09/06/02					0.165	0.18
11890	11633 Natural Bridge	C	09/09/02	0.0065	0.0078				
11890	11633 Natural Bridge	C	09/09/02					0.267	0.373
10821	14839 Larchburr	R	09/26/02	0.0642	0.0174				
10821	14839 Larchburr	R	09/26/02		0.017				
11969	11351 Long road et al	C	09/06/02	0.0069	0.0094				
11969	11351 Long road et al	C	10/15/02	0.0057	0.0041				
11969	11351 Long road et al	C	10/16/02	0.0057	0.005				
11969	11351 Long road et al	C	10/16/02					10.156	0.023
11828	5123 N Lindberg	R	11/07/02	<0.0065	0.0064			<0.013	<0.013
10830	14846 Larchburr	R	12/11/02	0.0075	0.0102				
10830	14846 Larchburr	R	12/11/02		0.0082				
10830	14846 Larchburr	R	12/11/02		0.0072				
	Start Building	C	11/25/02	0.0095	0.1172				
	Start Building	C	12/02/02	0.0956	0.0145				

	Start Building	C	12/02/02					0.219	<0.01
	Start Building	C	12/04/02	0.0098	0.0089				
	Start Building	C	12/04/02					<0.01	<0.009
	Start Building	C	12/05/02	<0.0052	0.0057				
	Start Building	C	12/05/02					<0.01	0.417
	Start Building	C	12/06/02	0.0053	0.0053				
	Start Building	C	12/06/02					<0.01	<0.01
	Start Building	C	12/09/02	<0.0051	0.0066				
	Start Building	C	12/10/02	<0.0175	<0.0189				
11808	12849 Primgar	R	11/21/03	0.0038	0.0064				
11808	12849 Primgar	R	11/21/03	0.0046	0.024				
	St. Mary's Church	C	05/07/04	<0.0027	<0.0027	<0.005	<0.005		
	St. Mary's Church	C	05/07/04	<0.0027	<0.0027	<0.005	<0.005		
	St. Mary's Church	C	05/07/04					0.031	0.042

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ACKNOWLEDGMENTS

The authors wish to thank Wayne Berman, Ron Freyberg, and Florence Fulk for their excellent peer review comments and suggestions.

Also special thanks to Marilyn Joos, Phyllis McKenna, and Shanelle Steward for assisting in data entry and verification and Janey Wilmoth for proofreading.